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(54) USER-SPECIFIC NOISE SUPPRESSION FOR VOICE QUALITY IMPROVEMENTS

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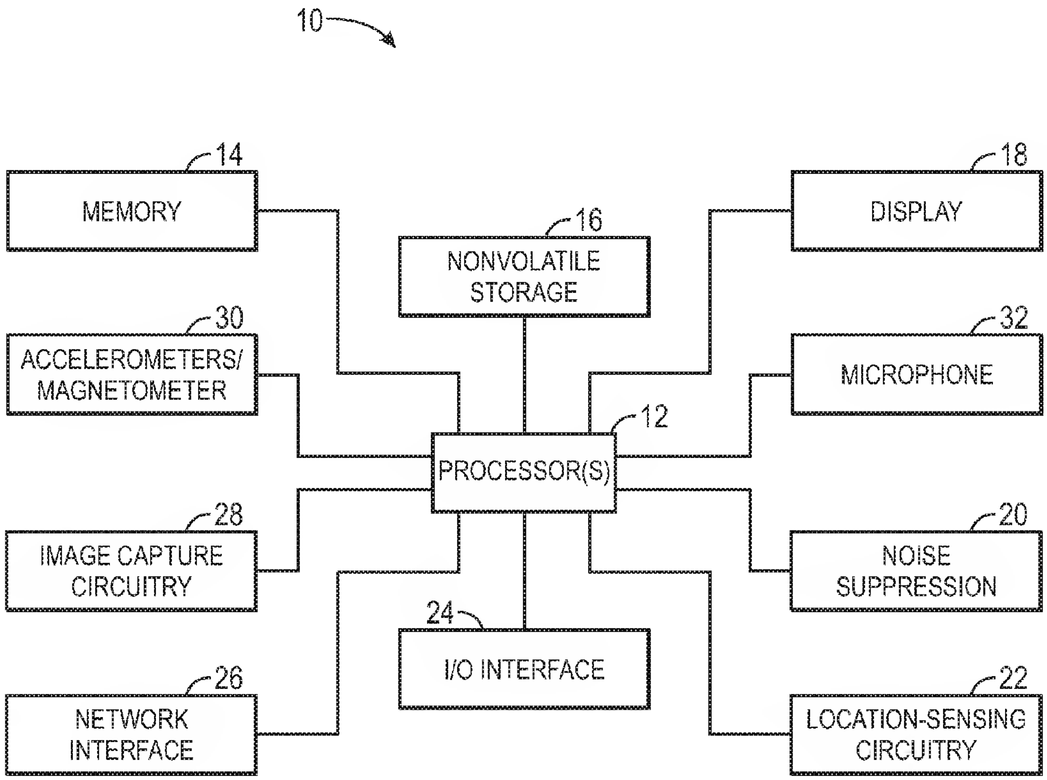
(57) ABSTRACT

Systems, methods, and devices for user-specific noise suppression are provided. For example, when a voice-related feature of an electronic device is in use, the electronic device may receive an audio signal that includes a user voice. Since noise, such as ambient sounds, also may be received by the electronic device at this time, the electronic device may suppress such noise in the audio signal. In particular, the electronic device may suppress the noise in the audio signal while substantially preserving the user voice via user-specific noise suppression parameters. These user-specific noise suppression parameters may be based at least in part on a user noise suppression preference or a user voice profile, or a combination thereof.



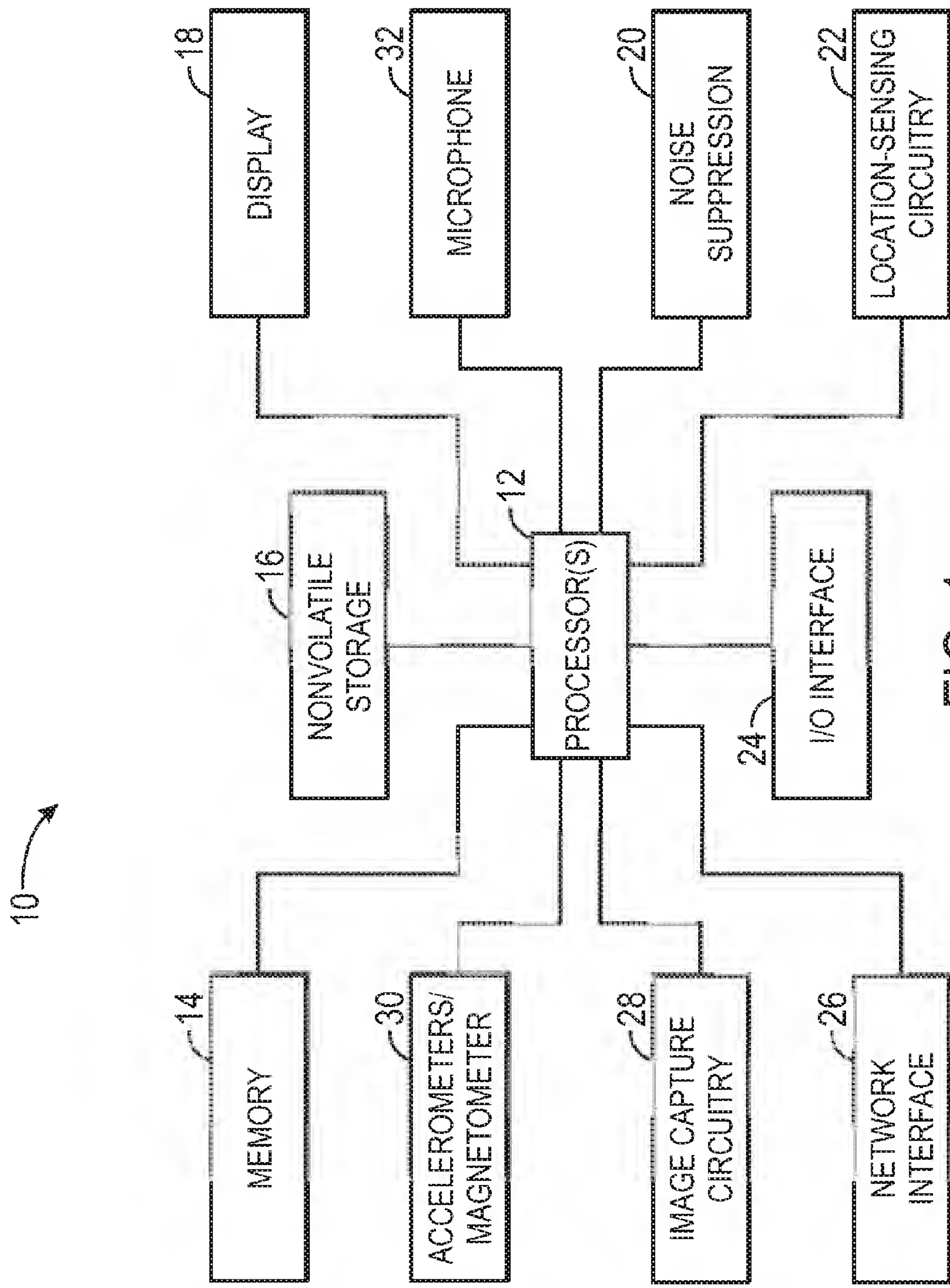
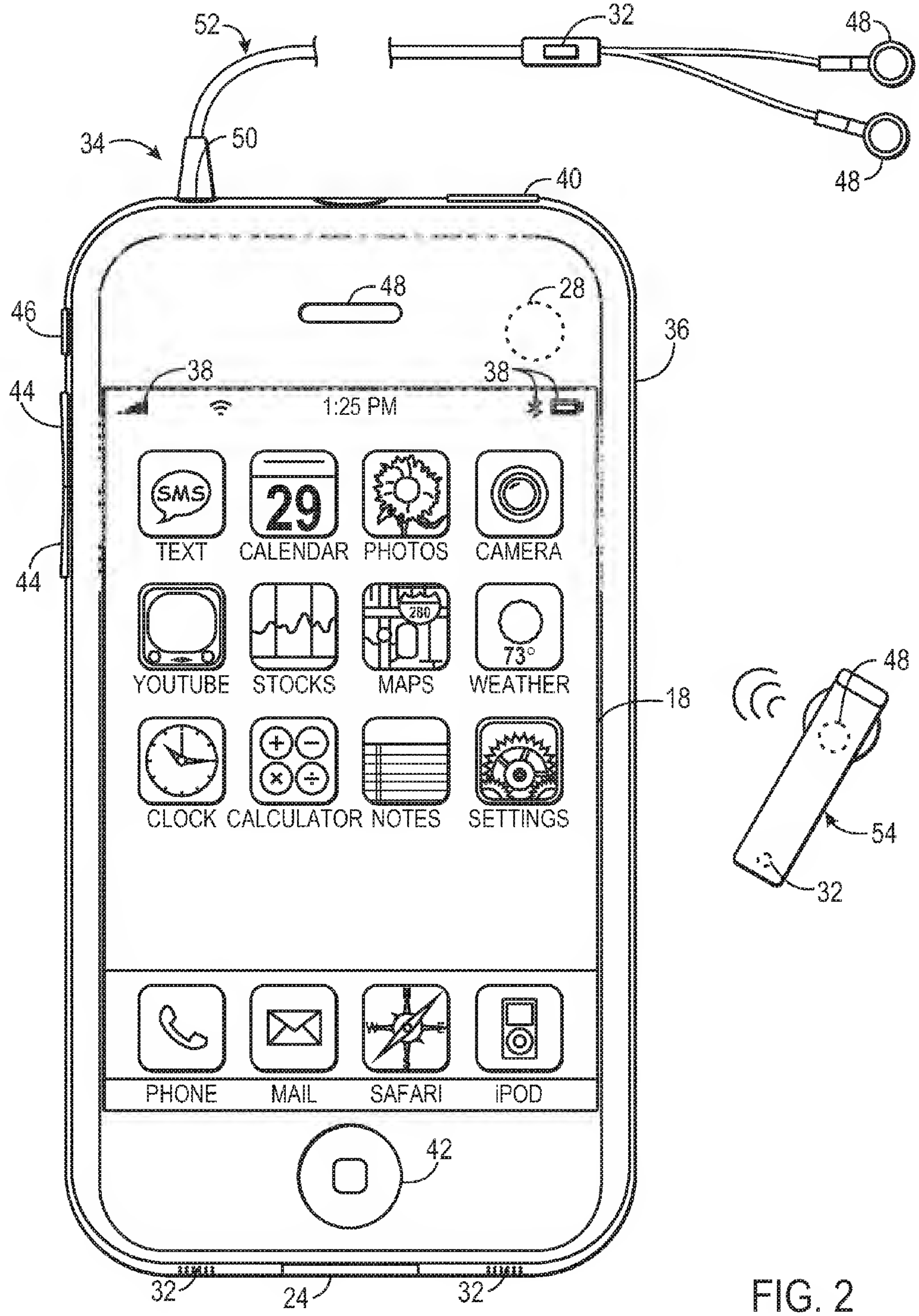

10
12
PROCESSOR(S)
14
MEMORY
16
NONVOLATILE STORAGE
18
DISPLAY
20
NOISE SUPPRESSION
22
LOCATION-SENSING CIRCUITRY
24
I/O INTERFACE
26
NETWORK INTERFACE
28
IMAGE CAPTURE CIRCUITRY
30
ACCELEROMETERS/ MAGNETOMETER
32
MICROPHONE

FIG. 1



52
32
48
34
50
40
48
46
48
28
36
44
38
38
1:25 PM
SMS
29
TEXT
CALENDAR
PHOTOS
CAMERA
44
280
73°
YOUTUBE
STOCKS
MAPS
WEATHER
48
18
CLOCK
CALCULATOR
NOTES
SETTINGS
54
32
PHONE
MAIL
SAFARI
iPOD
42
32
24
32

FIG. 2

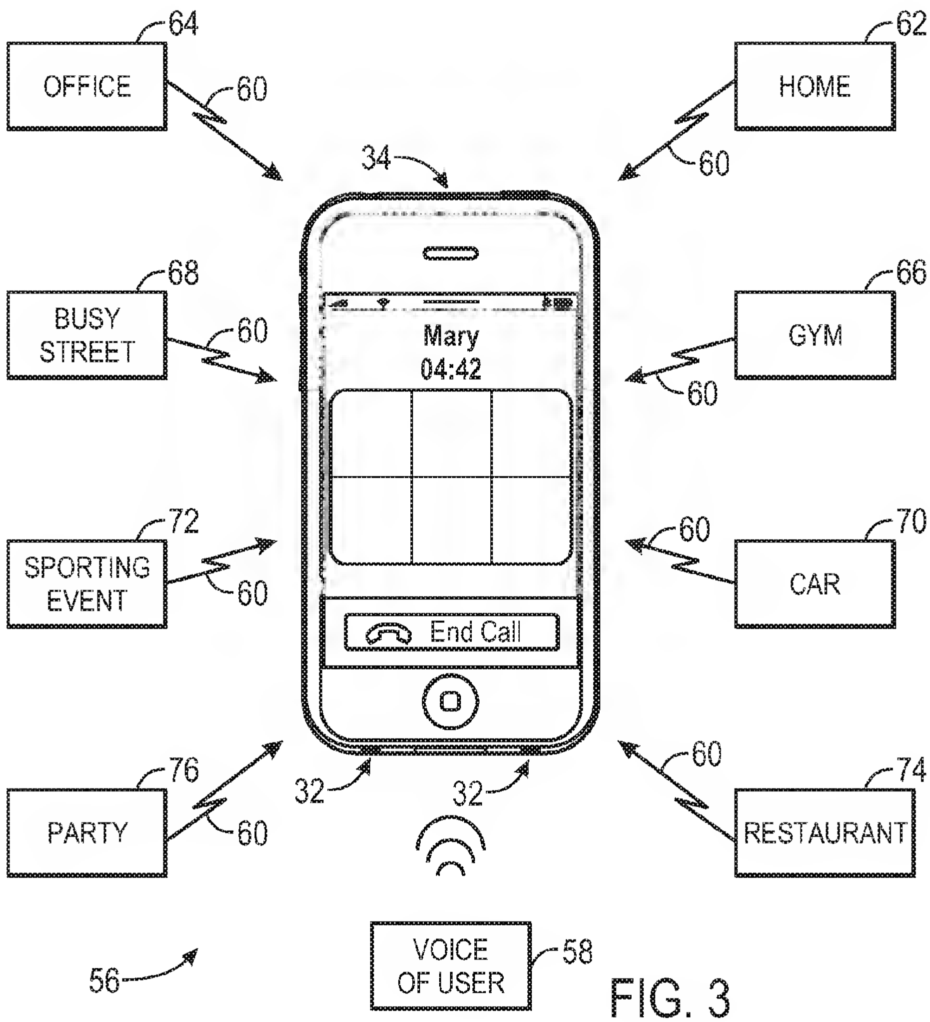

64
OFFICE
60
62
HOME
60
34
68
BUSY STREET
60
66
GYM
60
Mary
04:42
72
SPORTING EVENT
60
60
70
CAR
End Call
76
PARTY
60
32
32
60
74
RESTAURANT
56
VOICE OF USER
58

FIG. 3

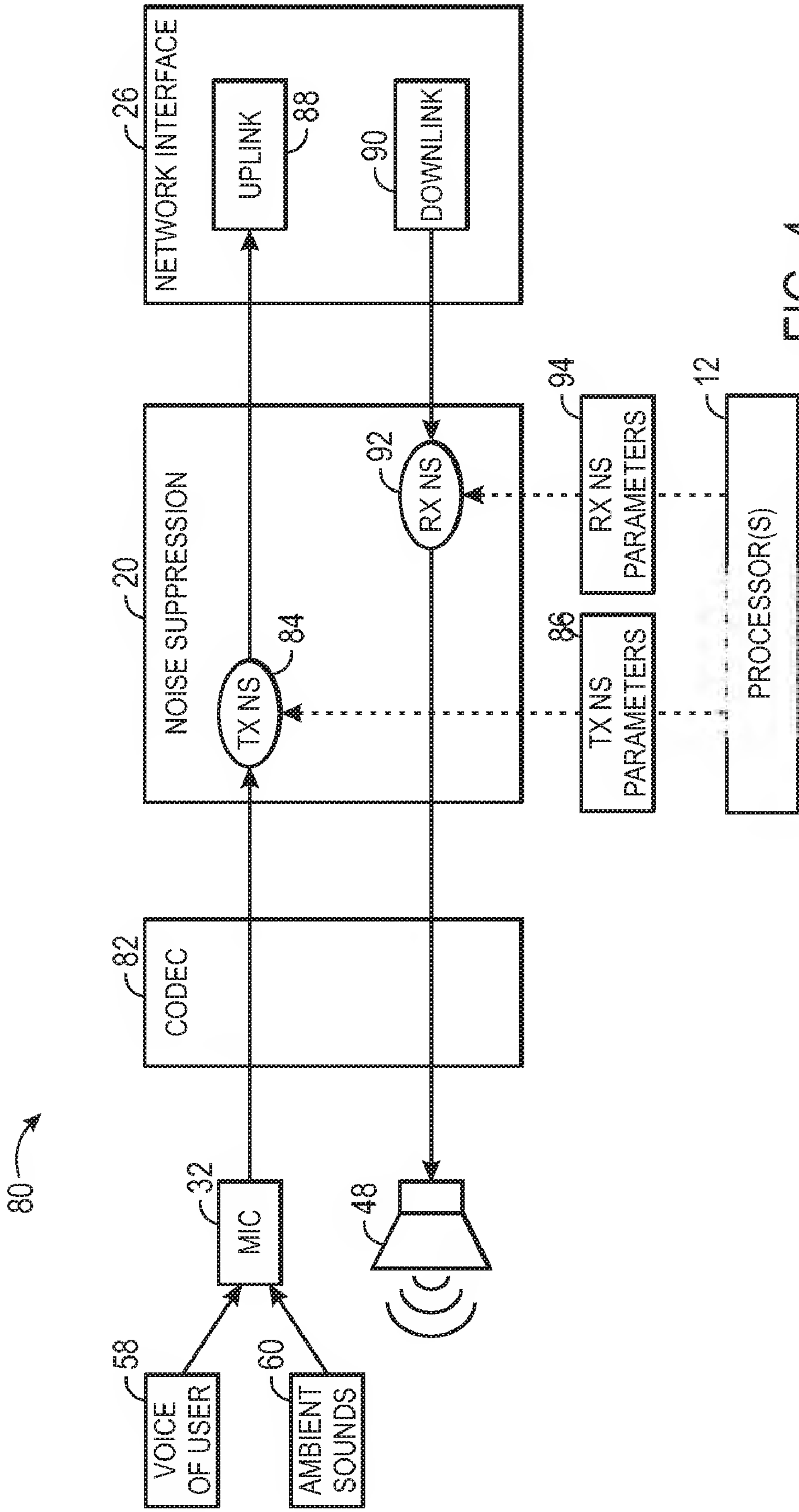

80
VOICE OF USER
58
AMBIENT SOUNDS
60
MIC
32
48
CODEC
82
NOISE SUPPRESSION
20
TX NS
84
RX NS
92
TX NS PARAMETERS
86
RX NS PARAMETERS
94
PROCESSOR(S)
12
NETWORK INTERFACE
26
UPLINK
88
DOWNLINK
90

FIG. 4

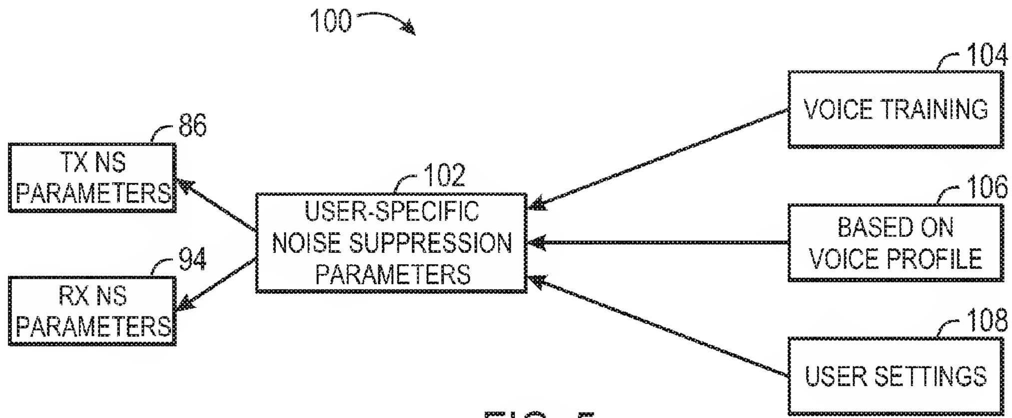

100
104
VOICE TRAINING
86
TX NS PARAMETERS
102
USER-SPECIFIC NOISE SUPPRESSION PARAMETERS
106
BASED ON VOICE PROFILE
94
RX NS PARAMETERS
108
USER SETTINGS

FIG. 5

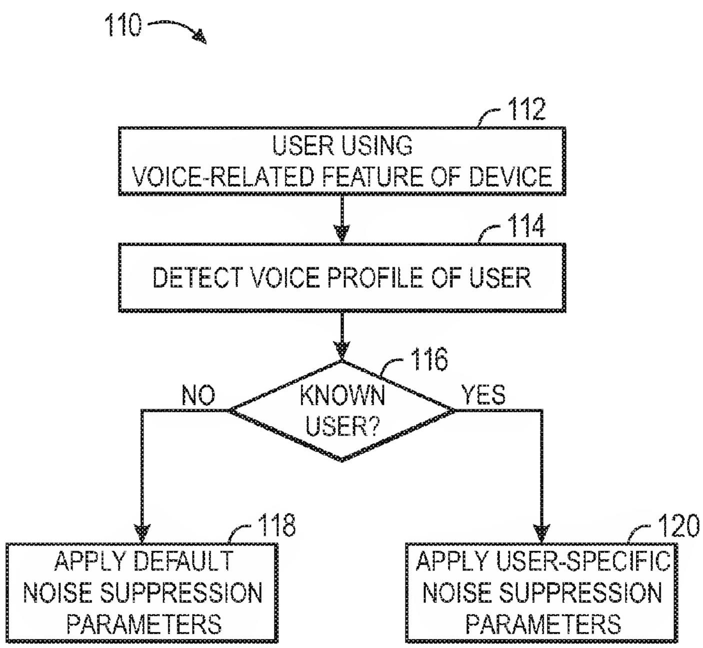

110
112
USER USING VOICE-RELATED FEATURE OF DEVICE
114
DETECT VOICE PROFILE OF USER
116
KNOWN USER?
NO
YES
118
APPLY DEFAULT NOISE SUPPRESSION PARAMETERS
120
APPLY USER-SPECIFIC NOISE SUPPRESSION PARAMETERS

FIG. 6

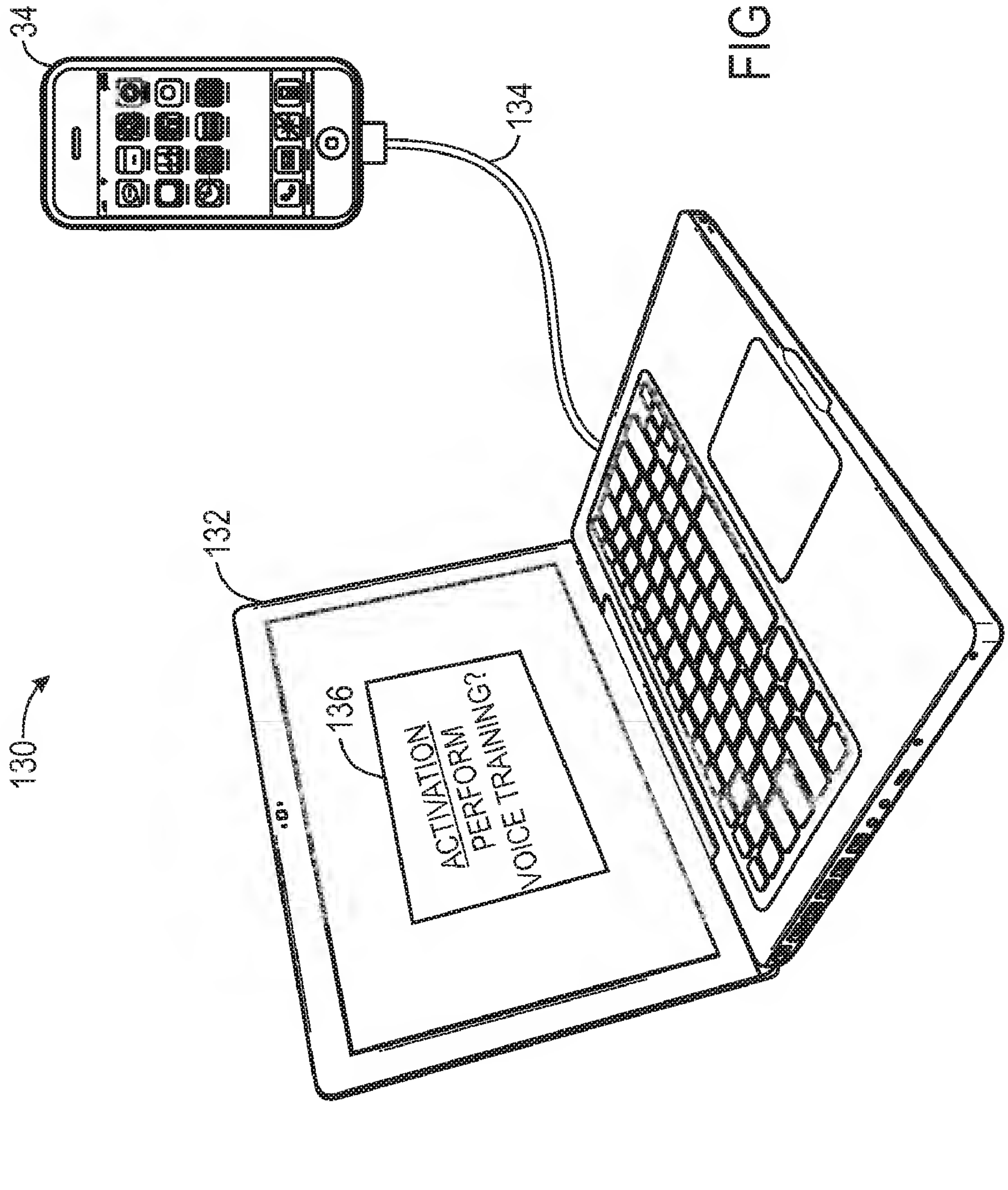


FIG. 7

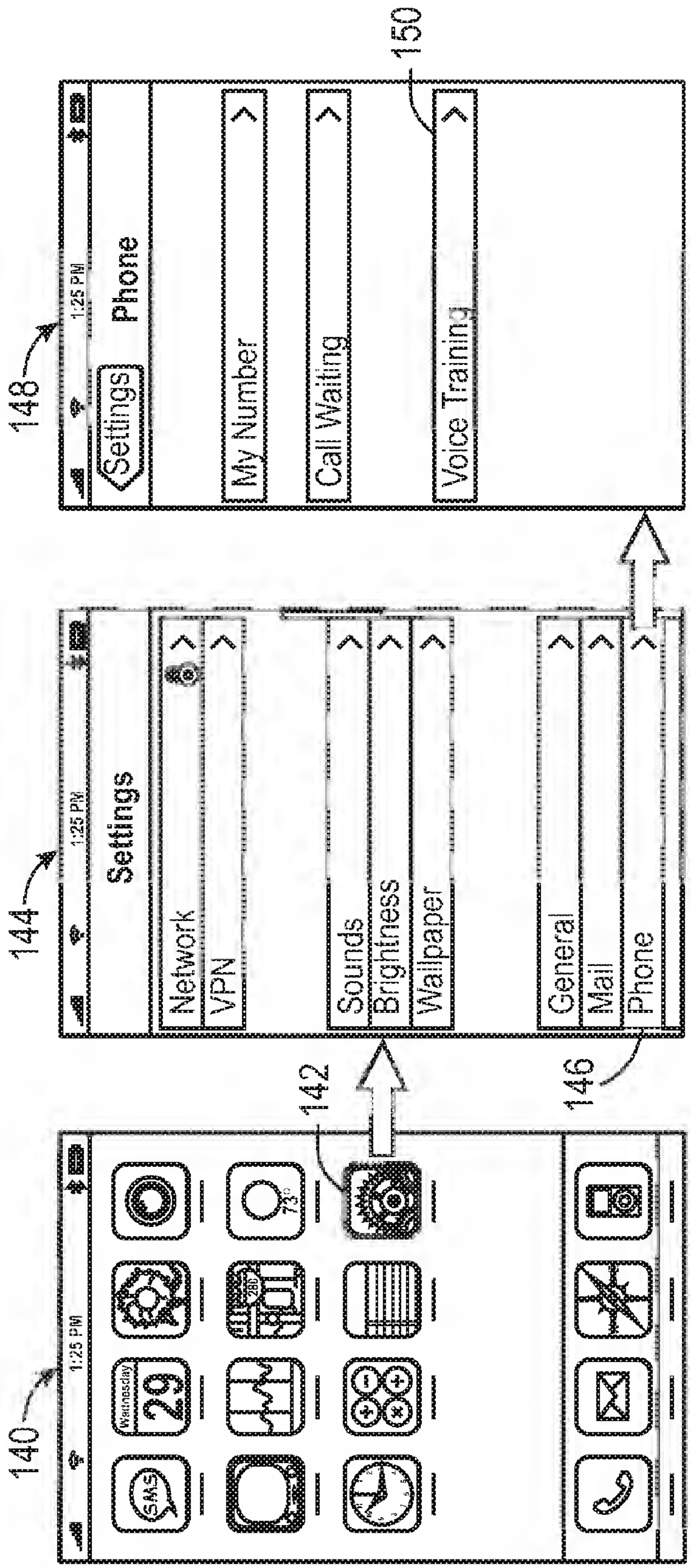

140
1:25 PM
Wednesday
29
SMS
73°
142
144
Settings
Network
VPN
Sounds
Brightness
Wallpaper
General
Mail
Phone
146
148
Settings
Phone
My Number
Call Waiting
Voice Training
150

FIG. 8

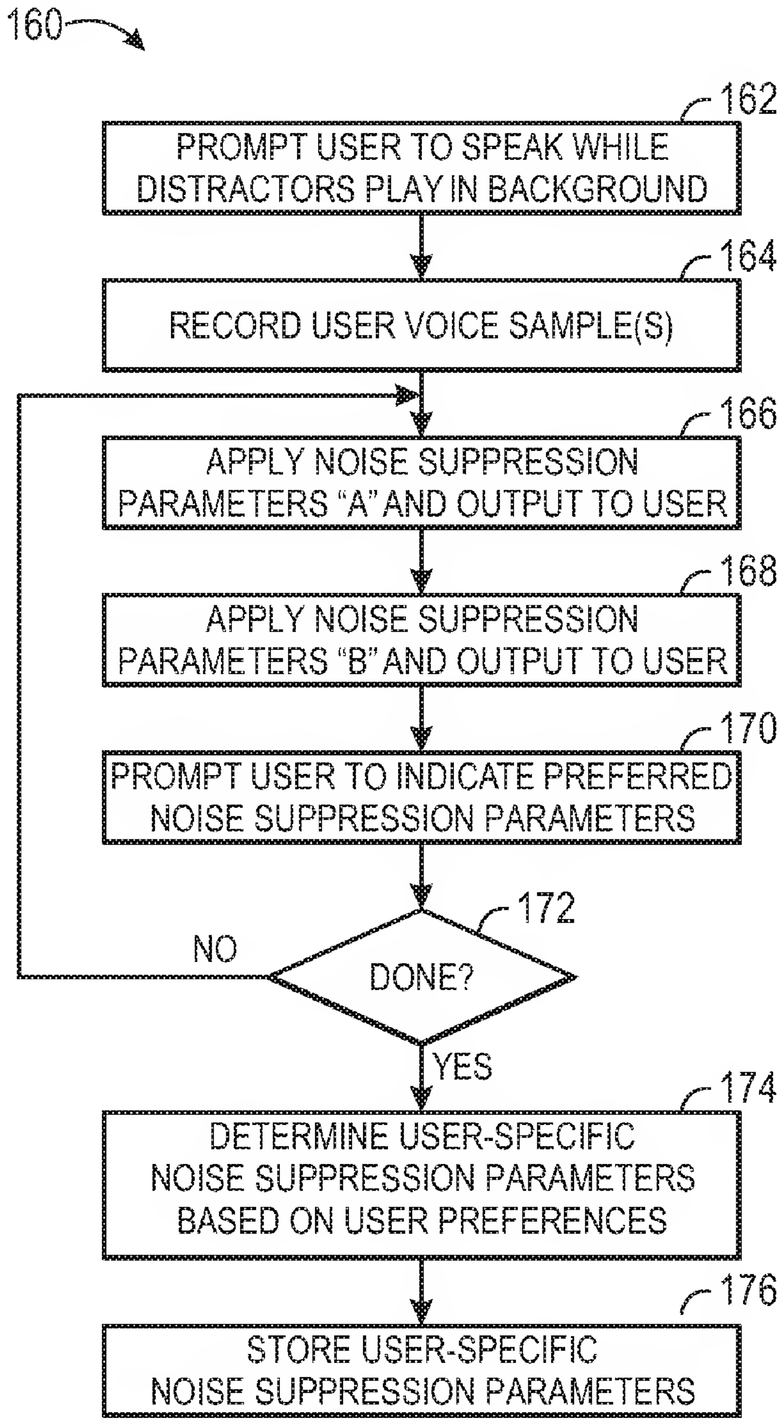
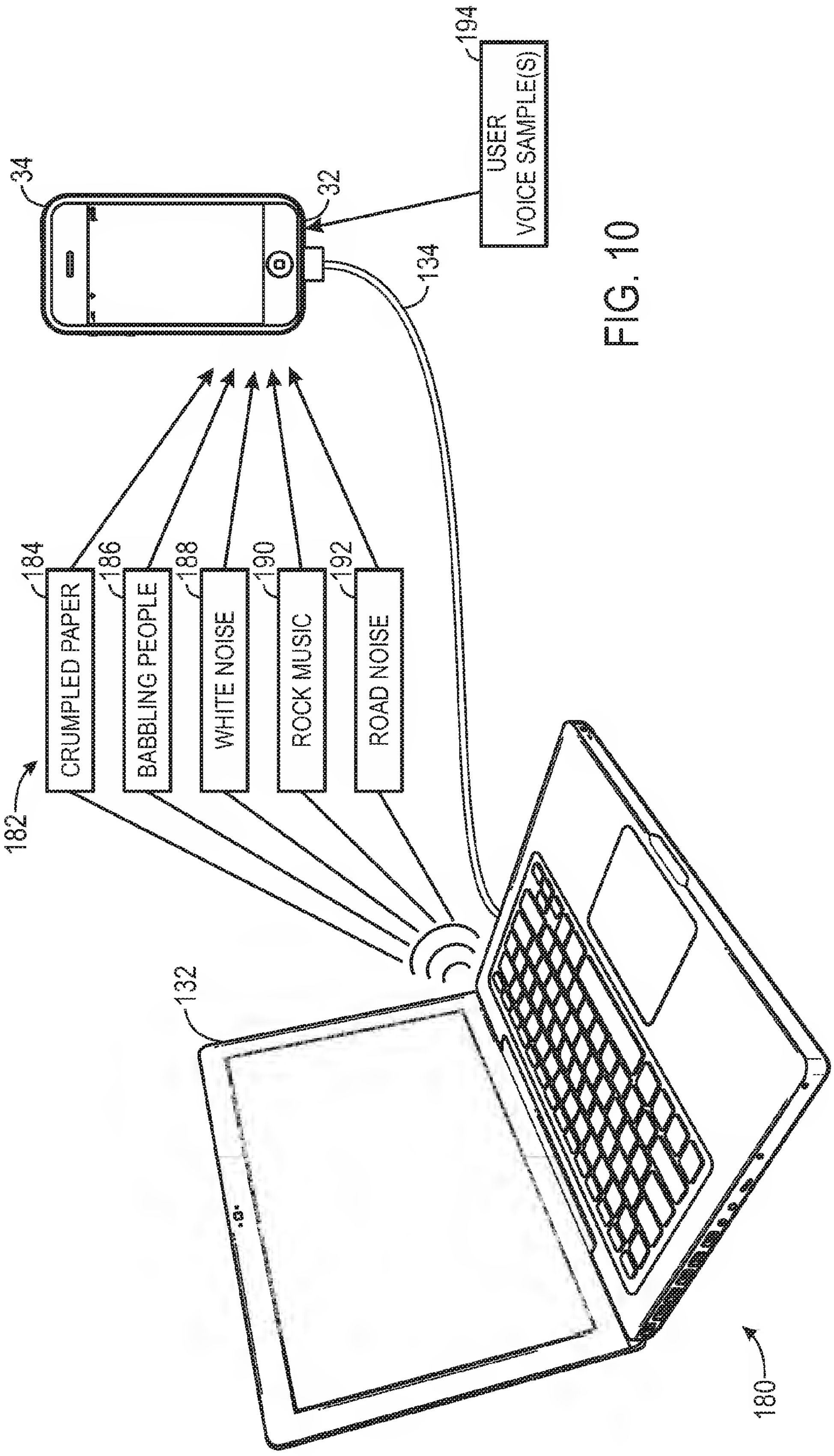

160
162
PROMPT USER TO SPEAK WHILE DISTRACTORS PLAY IN BACKGROUND
164
RECORD USER VOICE SAMPLE(S)
166
APPLY NOISE SUPPRESSION PARAMETERS "A" AND OUTPUT TO USER
168
APPLY NOISE SUPPRESSION PARAMETERS "B" AND OUTPUT TO USER
170
PROMPT USER TO INDICATE PREFERRED NOISE SUPPRESSION PARAMETERS
172
DONE?
NO
YES
174
DETERMINE USER-SPECIFIC NOISE SUPPRESSION PARAMETERS BASED ON USER PREFERENCES
176
STORE USER-SPECIFIC NOISE SUPPRESSION PARAMETERS

FIG. 9



34
32
USER
VOICE SAMPLE(S)
194
134
182
CRUMPLED PAPER
184
BABBLING PEOPLE
186
WHITE NOISE
188
ROCK MUSIC
190
ROAD NOISE
192
132
180

FIG. 10

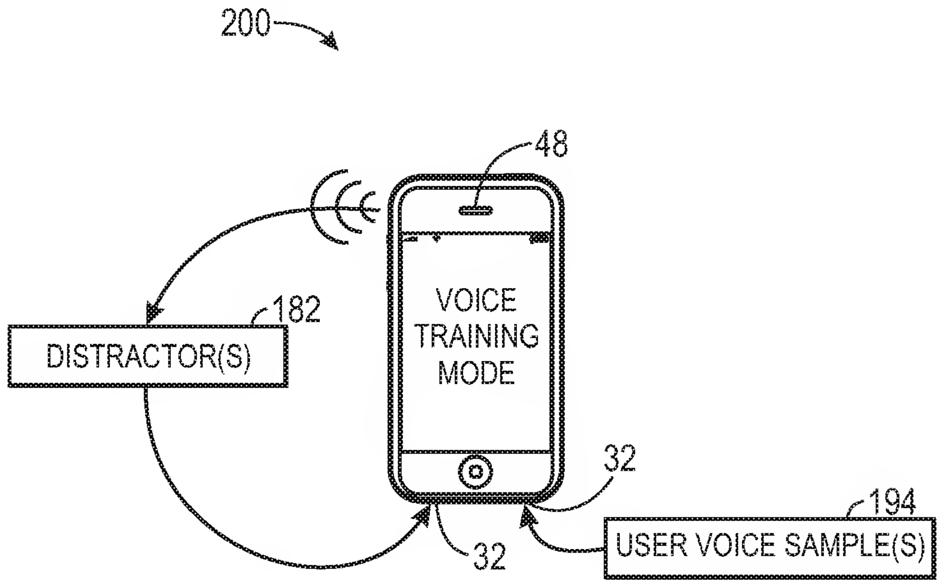

200
48
182
DISTRACTOR(S)
VOICE
TRAINING
MODE
32
194
USER VOICE SAMPLE(S)
32

FIG. 11

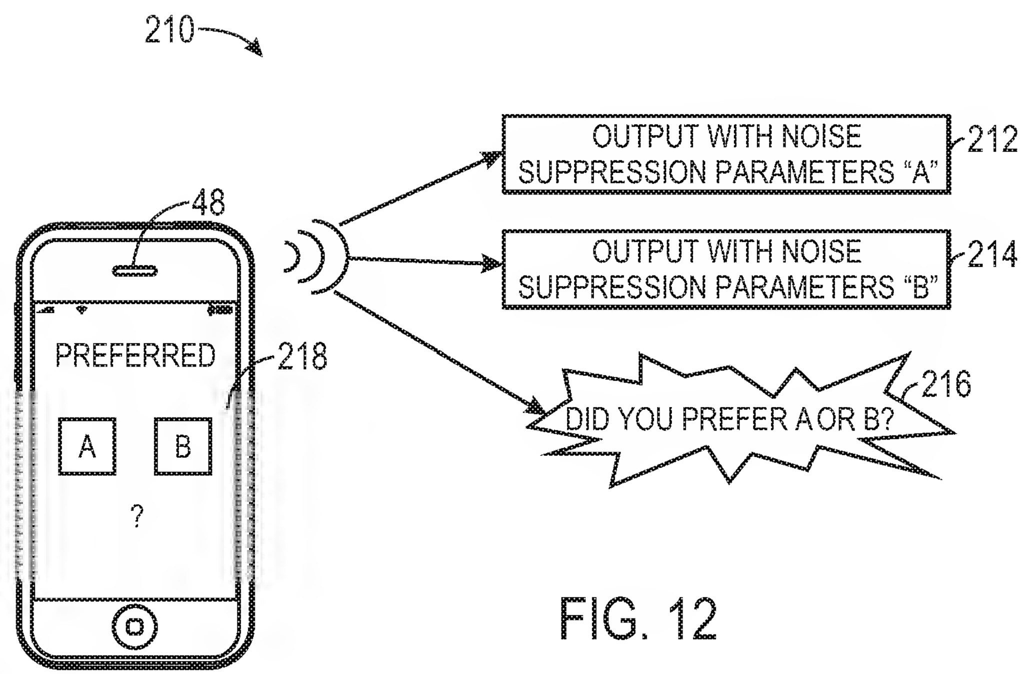

210
48
PREFERRED
218
A
B
?
OUTPUT WITH NOISE
SUPPRESSION PARAMETERS "A"
212
OUTPUT WITH NOISE
SUPPRESSION PARAMETERS "B"
214
DID YOU PREFER A OR B?
216

FIG. 12

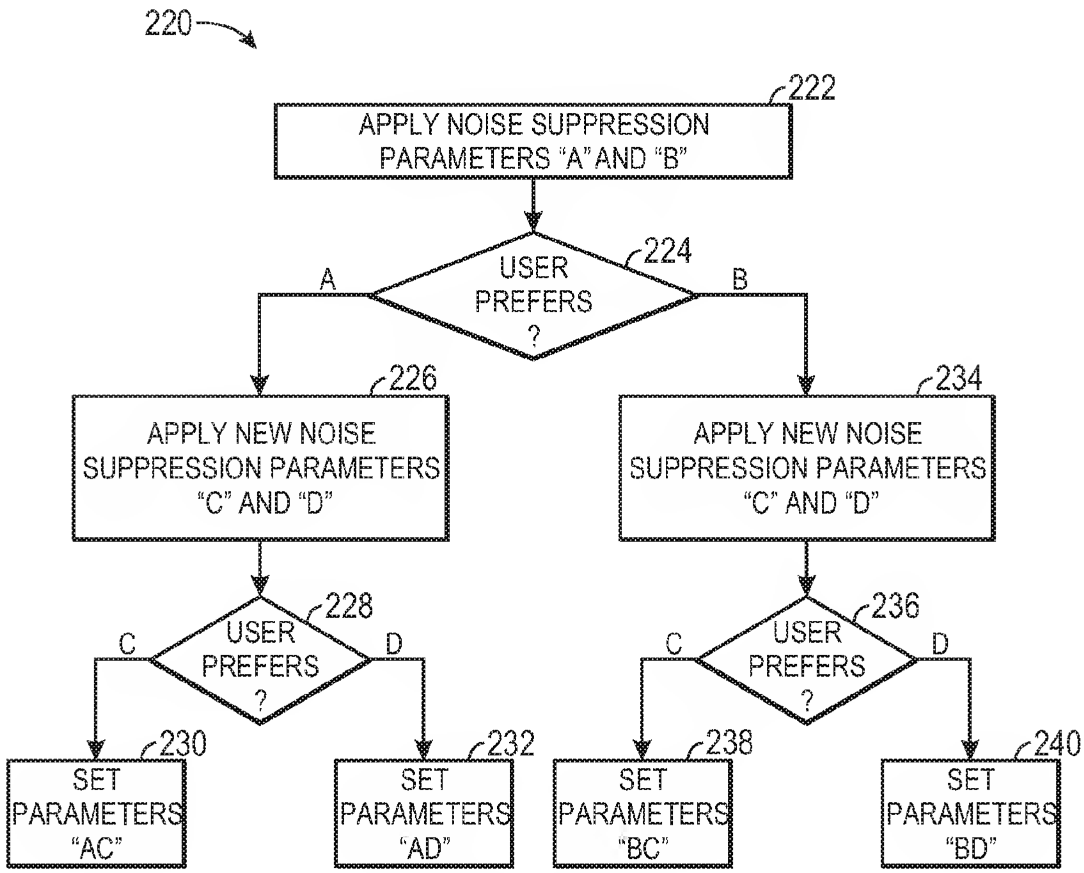

220
222
APPLY NOISE SUPPRESSION PARAMETERS "A" AND "B"
224
USER PREFERS ?
A
B
226
APPLY NEW NOISE SUPPRESSION PARAMETERS "C" AND "D"
234
APPLY NEW NOISE SUPPRESSION PARAMETERS "C" AND "D"
228
USER PREFERS ?
C
D
236
USER PREFERS ?
C
D
230
SET PARAMETERS "AC"
232
SET PARAMETERS "AD"
238
SET PARAMETERS "BC"
240
SET PARAMETERS "BD"

FIG. 13

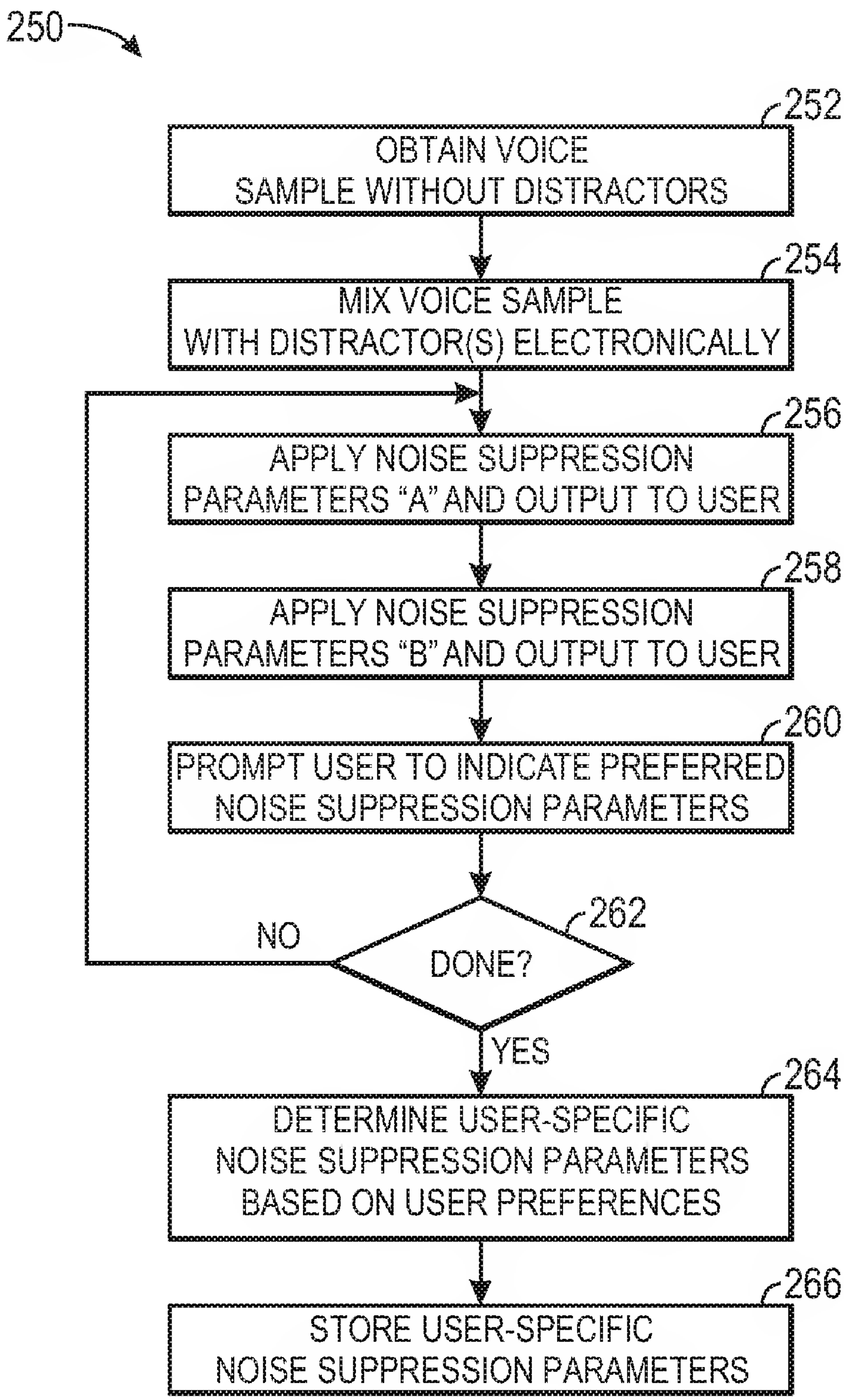

250
252
OBTAIN VOICE SAMPLE WITHOUT DISTRACTORS
254
MIX VOICE SAMPLE WITH DISTRACTOR(S) ELECTRONICALLY
256
APPLY NOISE SUPPRESSION PARAMETERS "A" AND OUTPUT TO USER
258
APPLY NOISE SUPPRESSION PARAMETERS "B" AND OUTPUT TO USER
260
PROMPT USER TO INDICATE PREFERRED NOISE SUPPRESSION PARAMETERS
262
DONE?
NO
YES
264
DETERMINE USER-SPECIFIC NOISE SUPPRESSION PARAMETERS BASED ON USER PREFERENCES
266
STORE USER-SPECIFIC NOISE SUPPRESSION PARAMETERS

FIG. 14

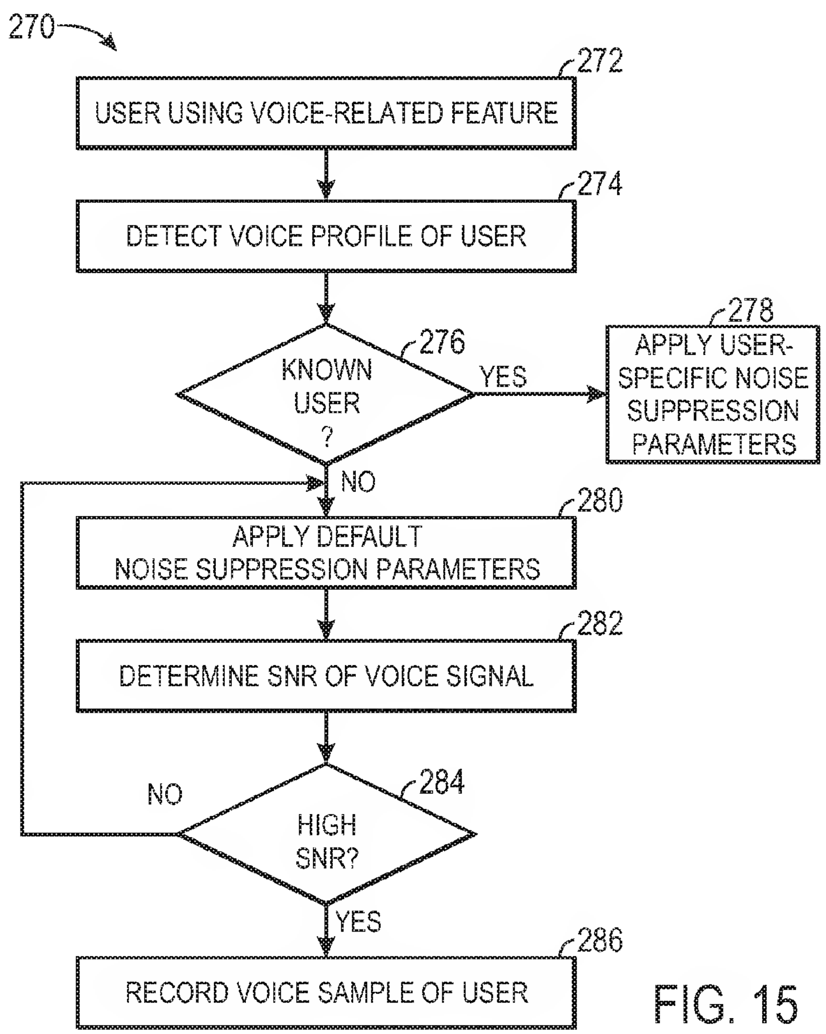


FIG. 15

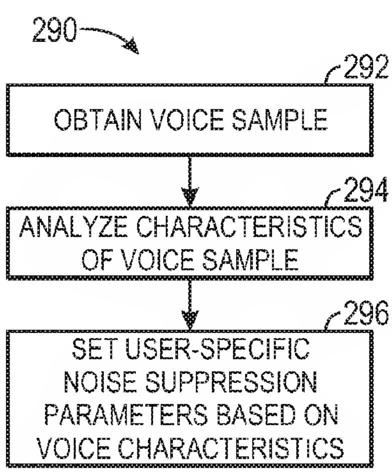


FIG. 16

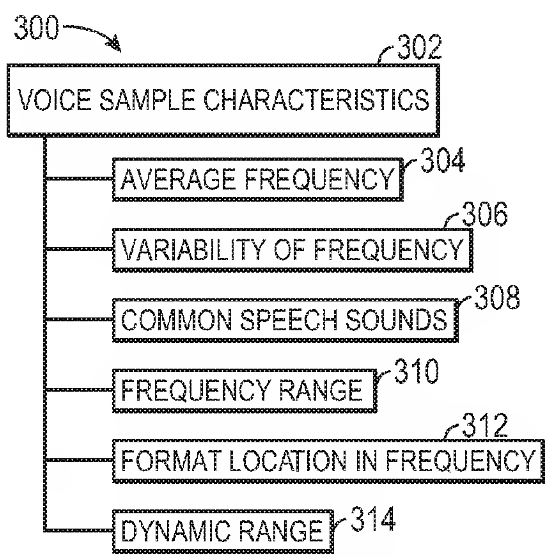


FIG. 17

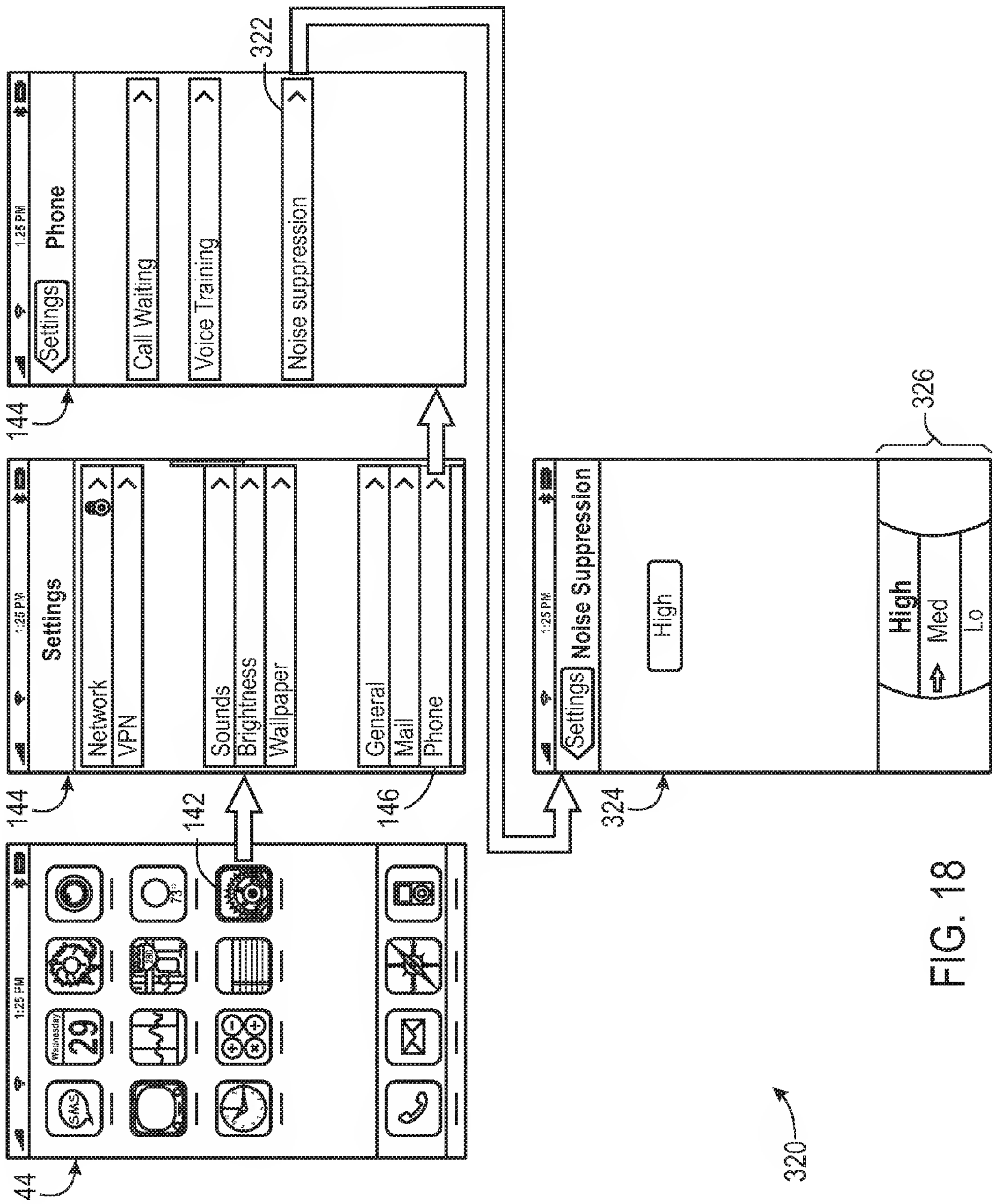

144
142
146
322
324
326
320
1:25 PM
Wednesday
29
SMS
Settings
Network
VPN
Sounds
Brightness
Wallpaper
General
Mail
Phone
Call Waiting
Voice Training
Noise suppression
Noise Suppression
High
Med
Lo

FIG. 18

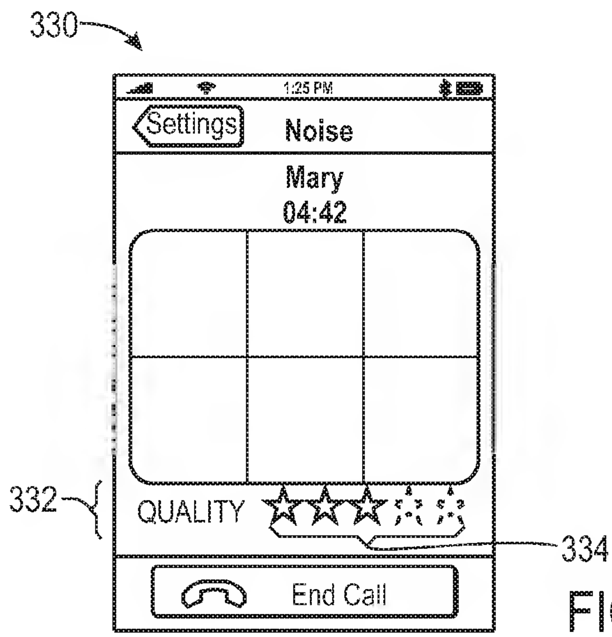

330
1:25 PM
Settings
Noise
Mary
04:42
332
QUALITY
334
End Call

FIG. 19

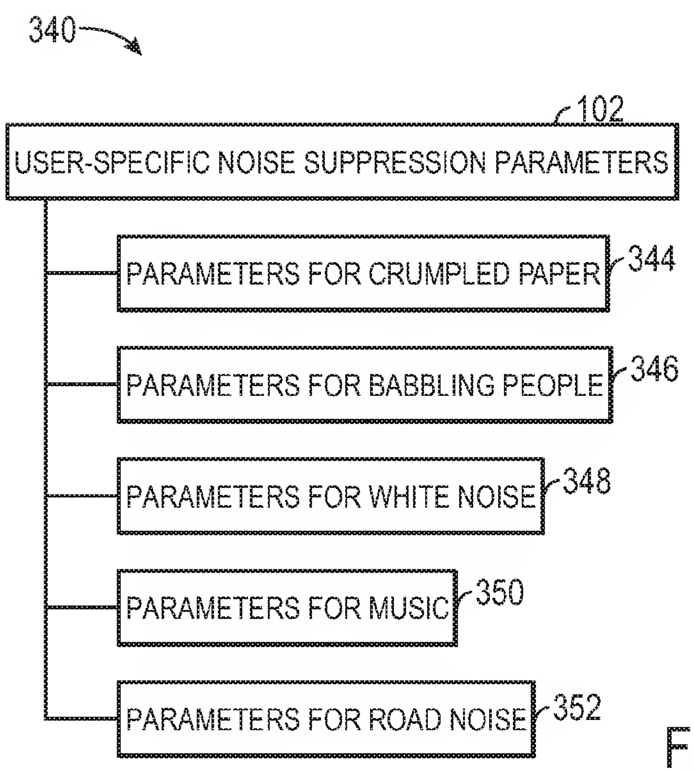

340
102
USER-SPECIFIC NOISE SUPPRESSION PARAMETERS
PARAMETERS FOR CRUMPLED PAPER
344
PARAMETERS FOR BABBLING PEOPLE
346
PARAMETERS FOR WHITE NOISE
348
PARAMETERS FOR MUSIC
350
PARAMETERS FOR ROAD NOISE
352

FIG. 20

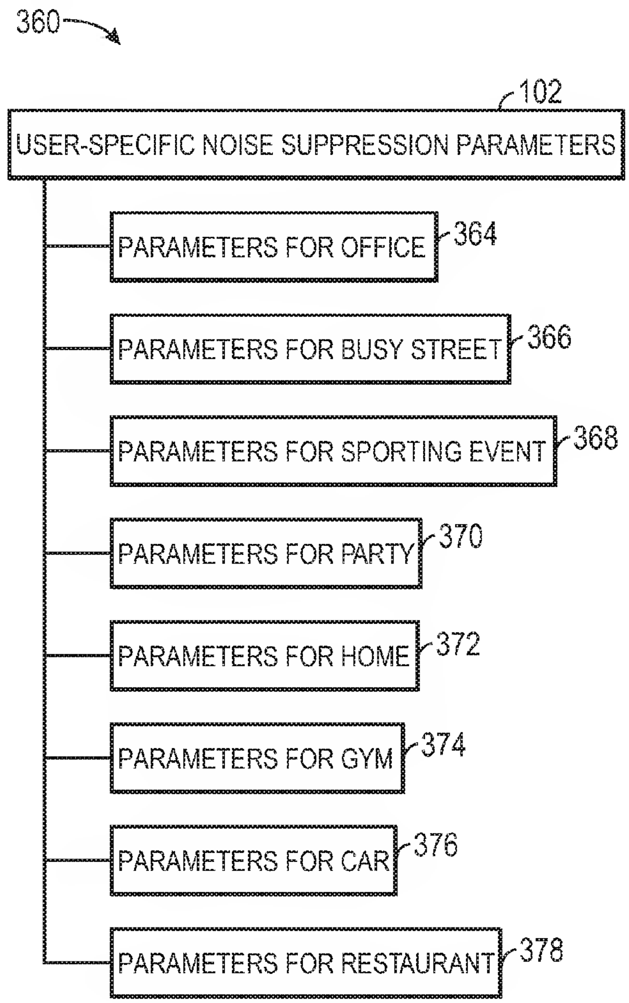

360
102
USER-SPECIFIC NOISE SUPPRESSION PARAMETERS
PARAMETERS FOR OFFICE
364
PARAMETERS FOR BUSY STREET
366
PARAMETERS FOR SPORTING EVENT
368
PARAMETERS FOR PARTY
370
PARAMETERS FOR HOME
372
PARAMETERS FOR GYM
374
PARAMETERS FOR CAR
376
PARAMETERS FOR RESTAURANT
378

FIG. 21

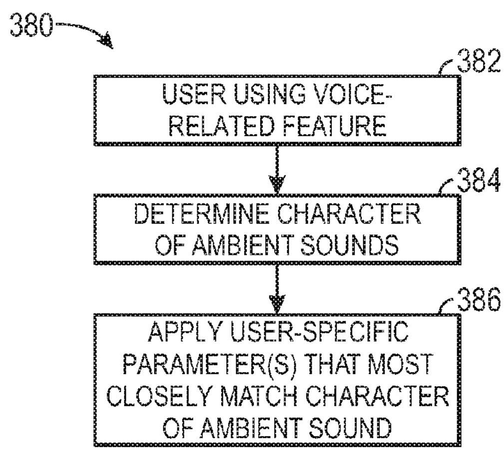

380
382
USER USING VOICE-RELATED FEATURE
384
DETERMINE CHARACTER OF AMBIENT SOUNDS
386
APPLY USER-SPECIFIC PARAMETER(S) THAT MOST CLOSELY MATCH CHARACTER OF AMBIENT SOUND

FIG. 22

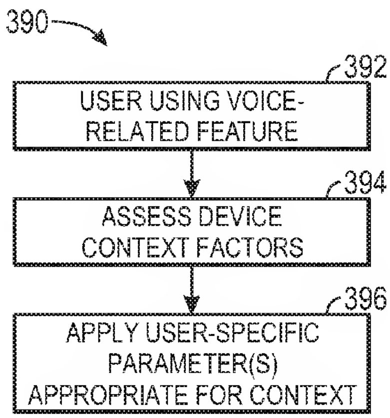


FIG. 23

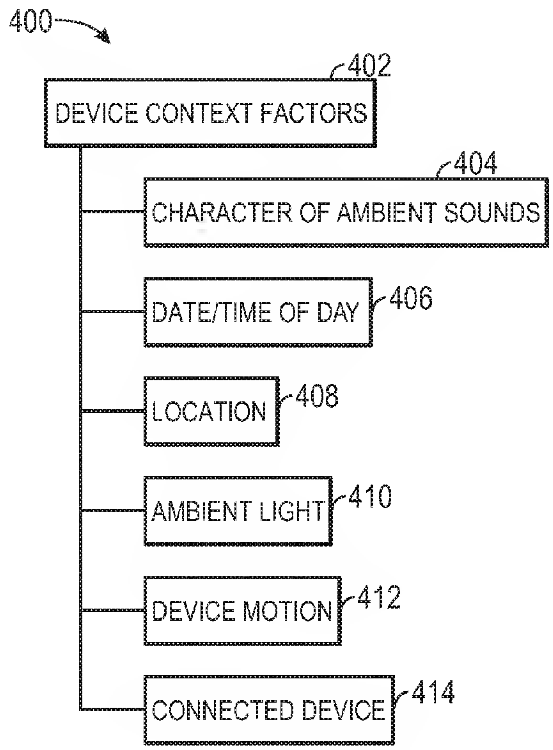


FIG. 24

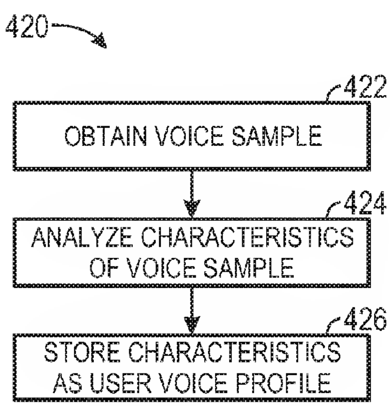


FIG. 25

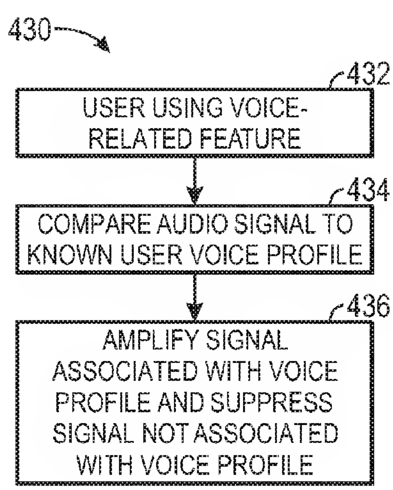


FIG. 26

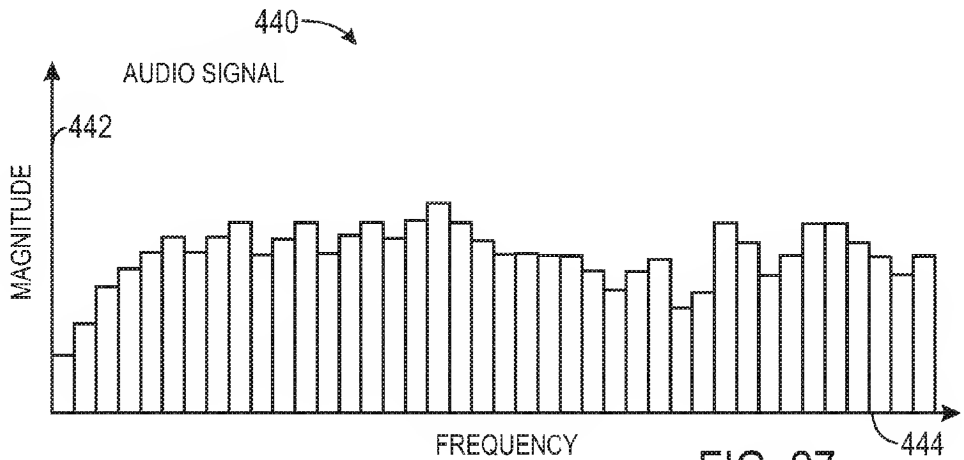


FIG. 27

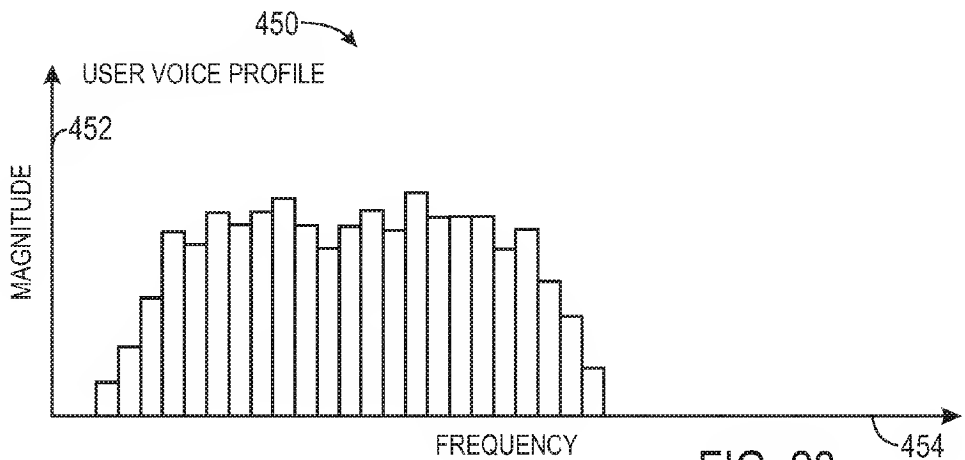


FIG. 28

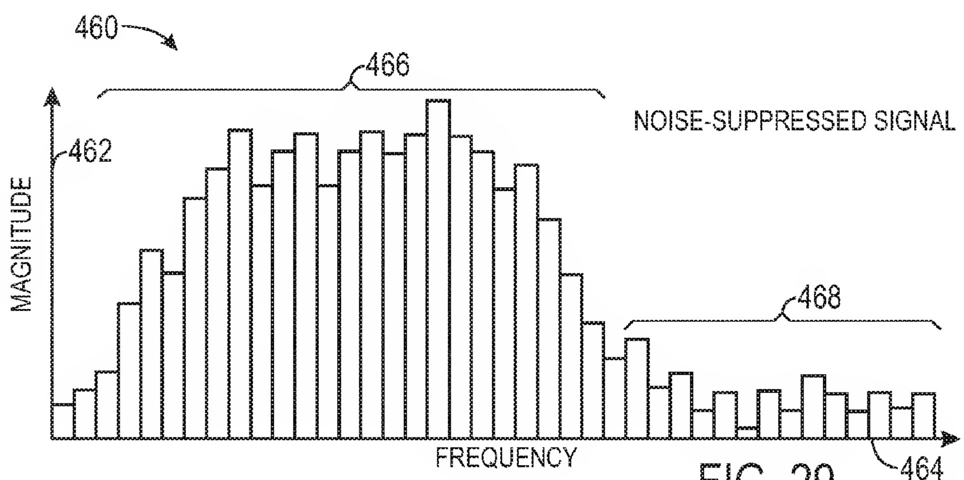


FIG. 29

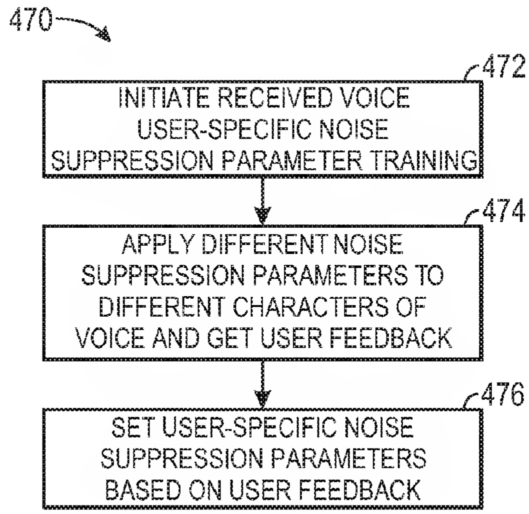


FIG. 30

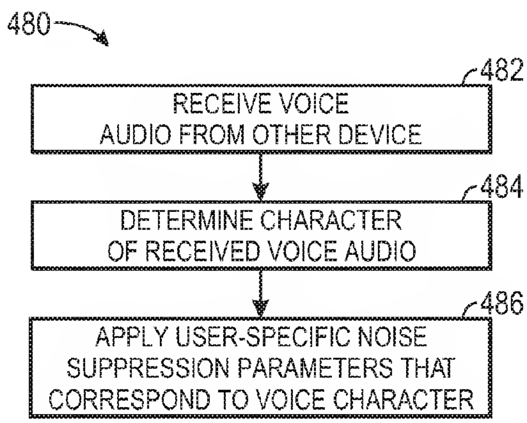


FIG. 31

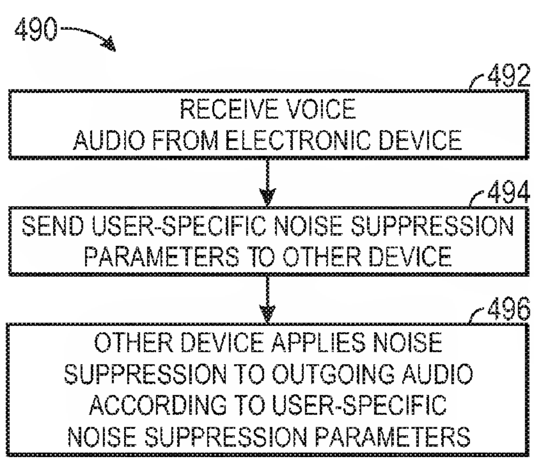


FIG. 32

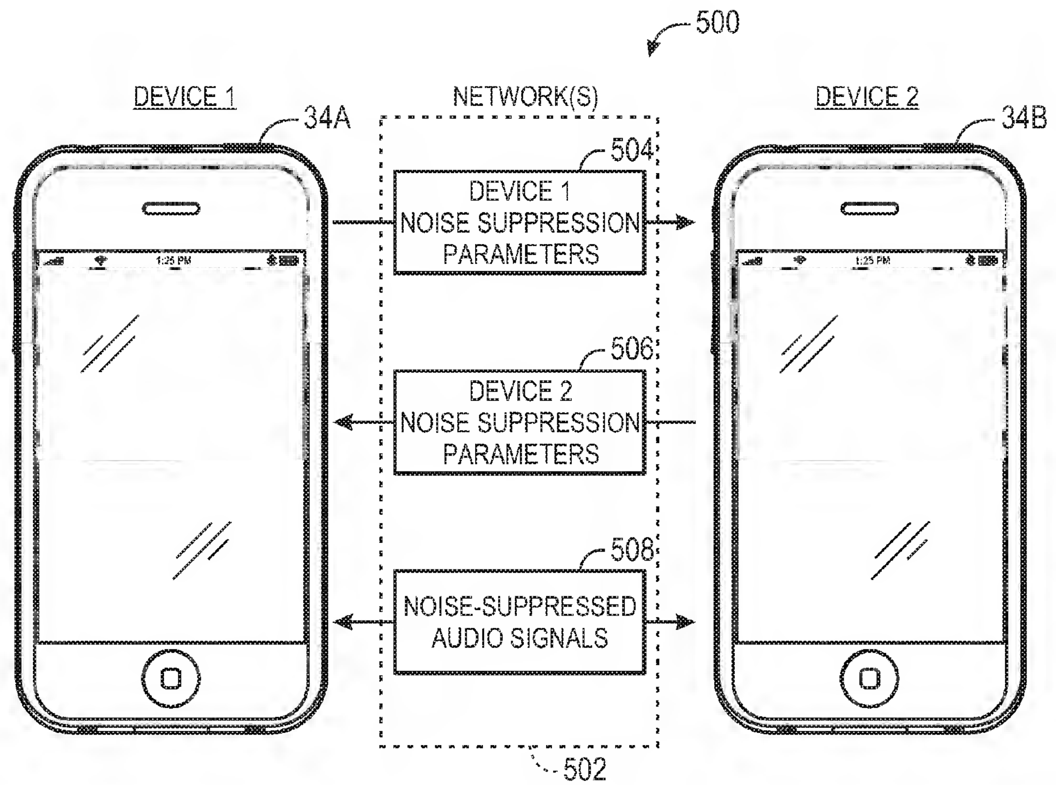

500
DEVICE 1
34A
NETWORK(S)
DEVICE 2
34B
504
DEVICE 1
NOISE SUPPRESSION
PARAMETERS
506
DEVICE 2
NOISE SUPPRESSION
PARAMETERS
508
NOISE-SUPPRESSED
AUDIO SIGNALS
502

FIG. 33

USER-SPECIFIC NOISE SUPPRESSION FOR VOICE QUALITY IMPROVEMENTS

BACKGROUND

[0001] The present disclosure relates generally to techniques for noise suppression and, more particularly, for user-specific noise suppression.

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] Many electronic devices employ voice-related features that involve recording and/or transmitting a user's voice. Voice note recording features, for example, may record voice notes spoken by the user. Similarly, a telephone feature of an electronic device may transmit the user's voice to another electronic device. When an electronic device obtains a user's voice, however, ambient sounds or background noise may be obtained at the same time. These ambient sounds may obscure the user's voice and, in some cases, may impede the proper functioning of a voice-related feature of the electronic device.

[0004] To reduce the effect of ambient sounds when a voice-related feature is in use, electronic devices may apply a variety of noise suppression schemes. Device manufactures may program such noise suppression schemes to operate according to certain predetermined generic parameters calculated to be well-received by most users. However, certain voices may be less well suited for these generic noise suppression parameters. Additionally, some users may prefer stronger or weaker noise suppression.

SUMMARY

[0005] A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

[0006] Embodiments of the present disclosure relate to systems, methods, and devices for user-specific noise suppression. For example, when a voice-related feature of an electronic device is in use, the electronic device may receive an audio signal that includes a user voice. Since noise, such as ambient sounds, also may be received by the electronic device at this time, the electronic device may suppress such noise in the audio signal. In particular, the electronic device may suppress the noise in the audio signal while substantially preserving the user voice via user-specific noise suppression parameters. These user-specific noise suppression parameters may be based at least in part on a user noise suppression preference or a user voice profile, or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Various aspects of this disclosure may be better understood upon reading the following detailed description and upon reference to the drawings in which:

[0008] FIG. **1** is a block diagram of an electronic device capable of performing the techniques disclosed herein, in accordance with an embodiment;

[0009] FIG. **2** is a schematic view of a handheld device representing one embodiment of the electronic device of FIG. **1**;

[0010] FIG. **3** is a schematic block diagram representing various context in which a voice-related feature of the electronic device of FIG. **1** may be used, in accordance with an embodiment;

[0011] FIG. **4** is a block diagram of noise suppression that may take place in the electronic device of FIG. **1**, in accordance with an embodiment;

[0012] FIG. **5** is a block diagram representing user-specific noise suppression parameters, in accordance with an embodiment;

[0013] FIG. **6** is a flow chart describing an embodiment of a method for applying user-specific noise suppression parameters in the electronic device of FIG. **1**;

[0014] FIG. **7** is a schematic diagram of the initiation of a voice training sequence when the handheld device of FIG. **2** is activated, in accordance with an embodiment;

[0015] FIG. **8** is a schematic diagram of a series of screens for selecting the initiation of a voice training sequence using the handheld device of FIG. **2**, in accordance with an embodiment;

[0016] FIG. **9** is a flowchart describing an embodiment of a method for determining user-specific noise suppression parameters via a voice training sequence;

[0017] FIGS. **10** and **11** are schematic diagrams for a manner of obtaining a user voice sample for voice training, in accordance with an embodiment;

[0018] FIG. **12** is a schematic diagram illustrating a manner of obtaining a noise suppression user preference during a voice training sequence, in accordance with an embodiment;

[0019] FIG. **13** is a flowchart describing an embodiment of a method for obtaining noise suppression user preferences during a voice training sequence;

[0020] FIG. **14** is a flowchart describing an embodiment of another method for performing a voice training sequence;

[0021] FIG. **15** is a flowchart describing an embodiment of a method for obtaining a high signal-to-noise ratio (SNR) user voice sample;

[0022] FIG. **16** is a flowchart describing an embodiment of a method for determining user-specific noise suppression parameters via analysis of a user voice sample;

[0023] FIG. **17** is a factor diagram describing characteristics of a user voice sample that may be considered while performing the method of FIG. **16**, in accordance with an embodiment;

[0024] FIG. **18** is a schematic diagram representing a series of screens that may be displayed on the handheld device of FIG. **2** to obtain a user-specific noise parameters via a user-selectable setting, in accordance with an embodiment;

[0025] FIG. **19** is a schematic diagram of a screen on the handheld device of FIG. **2** for obtaining user-specified noise suppression parameters in real-time while a voice-related feature of the handheld device is in use, in accordance with an embodiment;

[0026] FIGS. **20** and **21** are schematic diagrams representing various sub-parameters that may form the user-specific noise suppression parameters, in accordance with an embodiment;

[0027] FIG. **22** is a flowchart describing an embodiment of a method for applying certain sub-parameters of the user-specific parameters based on detected ambient sounds;

[0028] FIG. **23** is a flowchart describing an embodiment of a method for applying certain sub-parameters of the noise suppression parameters based on a context of use of the electronic device;

[0029] FIG. **24** is a factor diagram representing a variety of device context factors that may be employed in the method of FIG. **23**, in accordance with an embodiment;

[0030] FIG. **25** is a flowchart describing an embodiment of a method for obtaining a user voice profile;

[0031] FIG. **26** is a flowchart describing an embodiment of a method for applying noise suppression based on a user voice profile;

[0032] FIGS. **27-29** are plots depicting a manner of performing noise suppression of an audio signal based on a user voice profile, in accordance with an embodiment;

[0033] FIG. **30** is a flowchart describing an embodiment of a method for obtaining user-specific noise suppression parameters via a voice training sequence involving per-recorded voices;

[0034] FIG. **31** is a flowchart describing an embodiment of a method for applying user-specific noise suppression parameters to audio received from another electronic device;

[0035] FIG. **32** is a flowchart describing an embodiment of a method for causing another electronic device to engage in noise suppression based on the user-specific noise parameters of a first electronic device, in accordance with an embodiment; and

[0036] FIG. **33** is a schematic block diagram of a system for performing noise suppression on two electronic devices based on user-specific noise suppression parameters associated with the other electronic device, in accordance with an embodiment.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

[0037] One or more specific embodiments will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0038] Present embodiments relate to suppressing noise in an audio signal associated with a voice-related feature of an electronic device. Such a voice-related feature may include, for example, a voice note recording feature, a video recording feature, a telephone feature, and/or a voice command feature, each of which may involve an audio signal that includes a user's voice. In addition to the user's voice, however, the audio signal also may include ambient sounds present while the voice-related feature is in use. Since these ambient sounds may obscure the user's voice, the electronic device may apply noise suppression to the audio signal to filter out the ambient sounds while preserving the user's voice.

[0039] Rather than employ generic noise suppression parameters programmed at the manufacture of the device, noise suppression according to present embodiments may involve user-specific noise suppression parameters that may be unique to a user of the electronic device. These user-specific noise suppression parameters may be determined through voice training, based on a voice profile of the user, and/or based on a manually selected user setting. When noise suppression takes place based on user-specific parameters rather than generic parameters, the sound of the noise-suppressed signal may be more satisfying to the user. These user-specific noise suppression parameters may be employed in any voice-related feature, and may be used in connection with automatic gain control (AGC) and/or equalization (EQ) tuning.

[0040] As noted above, the user-specific noise suppression parameters may be determined using a voice training sequence. In such a voice training sequence, the electronic device may apply varying noise suppression parameters to a user's voice sample mixed with one or more distractors (e.g., simulated ambient sounds such as crumpled paper, white noise, babbling people, and so forth). The user may thereafter indicate which noise suppression parameters produce the most preferable sound. Based on the user's feedback, the electronic device may develop and store the user-specific noise suppression parameters for later use when a voice-related feature of the electronic device is in use.

[0041] Additionally or alternatively, the user-specific noise suppression parameters may be determined by the electronic device automatically depending on characteristics of the user's voice. Different users' voices may have a variety of different characteristics, including different average frequencies, different variability of frequencies, and/or different distinct sounds. Moreover, certain noise suppression parameters may be known to operate more effectively with certain voice characteristics. Thus, an electronic device according to certain present embodiments may determine the user-specific noise suppression parameters based on such user voice characteristics. In some embodiments, a user may manually set the noise suppression parameters by, for example, selecting a high/medium/low noise suppression strength selector or indicating a current call quality on the electronic device.

[0042] When the user-specific parameters have been determined, the electronic device may suppress various types of ambient sounds that may be heard while a voice-related feature is being used. In certain embodiments, the electronic device may analyze the character of the ambient sounds and apply a user-specific noise suppression parameter that is expected to thus suppress the current ambient sounds. In another embodiment, the electronic device may apply certain user-specific noise suppression parameters based on the current context in which the electronic device is being used.

[0043] In certain embodiments, the electronic device may perform noise suppression tailored to the user based on a user voice profile associated with the user. Thereafter, the electronic device may more effectively isolate ambient sounds from an audio signal when a voice-related feature is being used because the electronic device generally may expect which components of an audio signal correspond to the user's voice. For example, the electronic device may amplify components of an audio signal associated with a user voice profile while suppressing components of the audio signal not associated with the user voice profile.

[0044] User-specific noise suppression parameters also may be employed to suppress noise in audio signals containing voices other than that of the user that are received by the electronic device. For example, when the electronic device is used for a telephone or chat feature, the electronic device may employ the user-specific noise suppression parameters to an audio signal from a person with whom the user is corresponding. Since such an audio signal may have been previously processed by the sending device, such noise suppression may be relatively minor. In certain embodiments, the electronic device may transmit the user-specific noise suppression parameters to the sending device, so that the sending device may modify its noise suppression parameters accordingly. In the same way, two electronic devices may function systematically to suppress noise in outgoing audio signals according to each other's user-specific noise suppression parameters.

[0045] With the foregoing in mind, a general description of suitable electronic devices for performing the presently disclosed techniques is provided below. In particular, FIG. **1** is a block diagram depicting various components that may be present in an electronic device suitable for use with the present techniques. FIG. **2** represents one example of a suitable electronic device, which may be, as illustrated, a handheld electronic device having noise suppression capabilities.

[0046] Turning first to FIG. **1**, an electronic device **10** for performing the presently disclosed techniques may include, among other things, one or more processor(s) **12**, memory **14**, nonvolatile storage **16**, a display **18**, noise suppression **20**, location-sensing circuitry **22**, an input/output (I/O) interface **24**, network interfaces **26**, image capture circuitry **28**, accelerometers/magnetometer **30**, and a microphone **32**. The various functional blocks shown in FIG. **1** may include hardware elements (including circuitry), software elements (including computer code stored on a computer-readable medium) or a combination of both hardware and software elements. It should further be noted that FIG. **1** is merely one example of a particular implementation and is intended to illustrate the types of components that may be present in electronic device **10**.

[0047] By way of example, the electronic device **10** may represent a block diagram of the handheld device depicted in FIG. **2** or similar devices. Additionally or alternatively, the electronic device **10** may represent a system of electronic devices with certain characteristics. For example, a first electronic device may include at least a microphone **32**, which may provide audio to a second electronic device including the processor(s) **12** and other data processing circuitry. It should be noted that the data processing circuitry may be embodied wholly or in part as software, firmware, hardware or any combination thereof. Furthermore the data processing circuitry may be a single contained processing module or may be incorporated wholly or partially within any of the other elements within electronic device **10**. The data processing circuitry may also be partially embodied within electronic device **10** and partially embodied within another electronic device wired or wirelessly connected to device **10**. Finally, the data processing circuitry may be wholly implemented within another device wired or wirelessly connected to device **10**. As a non-limiting example, data processing circuitry might be embodied within a headset in connection with device **10**.

[0048] In the electronic device **10** of FIG. **1**, the processor (s) **12** and/or other data processing circuitry may be operably coupled with the memory **14** and the nonvolatile memory **16** to perform various algorithms for carrying out the presently disclosed techniques. Such programs or instructions executed by the processor(s) **12** may be stored in any suitable manufacture that includes one or more tangible, computer-readable media at least collectively storing the instructions or routines, such as the memory **14** and the nonvolatile storage **16**. Also, programs (e.g., an operating system) encoded on such a computer program product may also include instructions that may be executed by the processor(s) **12** to enable the electronic device **10** to provide various functionalities, including those described herein. The display **18** may be a touch-screen display, which may enable users to interact with a user interface of the electronic device **10**.

[0049] The noise suppression **20** may be performed by data processing circuitry such as the processor(s) **12** or by circuitry dedicated to performing certain noise suppression on audio signals processed by the electronic device **10**. For example, the noise suppression **20** may be performed by a baseband integrated circuit (IC), such as those manufactured by Infineon, based on externally provided noise suppression parameters. Additionally or alternatively, the noise suppression **20** may be performed in a telephone audio enhancement integrated circuit (IC) configured to perform noise suppression based on externally provided noise suppression parameters, such as those manufactured by Audience. These noise suppression ICs may operate at least partly based on certain noise suppression parameters. Varying such noise suppression parameters may vary the output of the noise suppression **20**.

[0050] The location-sensing circuitry **22** may represent device capabilities for determining the relative or absolute location of electronic device **10**. By way of example, the location-sensing circuitry **22** may represent Global Positioning System (GPS) circuitry, algorithms for estimating location based on proximate wireless networks, such as local Wi-Fi networks, and so forth. The I/O interface **24** may enable electronic device **10** to interface with various other electronic devices, as may the network interfaces **26**. The network interfaces **26** may include, for example, interfaces for a personal area network (PAN), such as a Bluetooth network, for a local area network (LAN), such as an 802.11x Wi-Fi network, and/or for a wide area network (WAN), such as a 3G cellular network. Through the network interfaces **26**, the electronic device **10** may interface with a wireless headset that includes a microphone **32**. The image capture circuitry **28** may enable image and/or video capture, and the accelerometers/magnetometer **30** may observe the movement and/or a relative orientation of the electronic device **10**.

[0051] When employed in connection with a voice-related feature of the electronic device **10**, such as a telephone feature or a voice recognition feature, the microphone **32** may obtain an audio signal of a user's voice. Though ambient sounds may also be obtained in the audio signal in addition to the user's voice, the noise suppression **20** may process the audio signal to exclude most ambient sounds based on certain user-specific noise suppression parameters. As described in greater detail below, the user-specific noise suppression parameters may be determined through voice training, based on a voice profile of the user, and/or based on a manually selected user setting.

[0052] FIG. **2** depicts a handheld device **34**, which represents one embodiment of the electronic device **10**. The handheld device **34** may represent, for example, a portable phone, a media player, a personal data organizer, a handheld game

platform, or any combination of such devices. By way of example, the handheld device **34** may be a model of an iPod® or iPhone® available from Apple Inc. of Cupertino, Calif.

[0053] The handheld device **34** may include an enclosure **36** to protect interior components from physical damage and to shield them from electromagnetic interference. The enclosure **36** may surround the display **18**, which may display indicator icons **38**. The indicator icons **38** may indicate, among other things, a cellular signal strength, Bluetooth connection, and/or battery life. The I/O interfaces **24** may open through the enclosure **36** and may include, for example, a proprietary I/O port from Apple Inc. to connect to external devices. As indicated in FIG. **2**, the reverse side of the handheld device **34** may include the image capture circuitry **28**.

[0054] User input structures **40**, **42**, **44**, and **46**, in combination with the display **18**, may allow a user to control the handheld device **34**. For example, the input structure **40** may activate or deactivate the handheld device **34**, the input structure **42** may navigate user interface **20** to a home screen, a user-configurable application screen, and/or activate a voice-recognition feature of the handheld device **34**, the input structures **44** may provide volume control, and the input structure **46** may toggle between vibrate and ring modes. The microphone **32** may obtain a user's voice for various voice-related features, and a speaker **48** may enable audio playback and/or certain phone capabilities. Headphone input **50** may provide a connection to external speakers and/or headphones.

[0055] As illustrated in FIG. **2**, a wired headset **52** may connect to the handheld device **34** via the headphone input **50**. The wired headset **52** may include two speakers **48** and a microphone **32**. The microphone **32** may enable a user to speak into the handheld device **34** in the same manner as the microphones **32** located on the handheld device **34**. In some embodiments, a button near the microphone **32** may cause the microphone **32** to awaken and/or may cause a voice-related feature of the handheld device **34** to activate. A wireless headset **54** may similarly connect to the handheld device **34** via a wireless interface (e.g., a Bluetooth interface) of the network interfaces **26**. Like the wired headset **52**, the wireless headset **54** may also include a speaker **48** and a microphone **32**. Also, in some embodiments, a button near the microphone **32** may cause the microphone **32** to awaken and/or may cause a voice-related feature of the handheld device **34** to activate. Additionally or alternatively, a standalone microphone **32** (not shown), which may lack an integrated speaker **48**, may interface with the handheld device **34** via the headphone input **50** or via one of the network interfaces **26**.

[0056] A user may use a voice-related feature of the electronic device **10**, such as a voice-recognition feature or a telephone feature, in a variety of contexts with various ambient sounds. FIG. **3** illustrates many such contexts **56** in which the electronic device **10**, depicted as the handheld device **34**, may obtain a user voice audio signal **58** and ambient sounds **60** while performing a voice-related feature. By way of example, the voice-related feature of the electronic device **10** may include, for example, a voice recognition feature, a voice note recording feature, a video recording feature, and/or a telephone feature. The voice-related feature may be implemented on the electronic device **10** in software carried out by the processor(s) **12** or other processors, and/or may be implemented in specialized hardware.

[0057] When the user speaks the voice audio signal **58**, it may enter the microphone **32** of the electronic device **10**. At approximately the same time, however, ambient sounds **60** also may enter the microphone **32**. The ambient sounds **60** may vary depending on the context **56** in which the electronic device **10** is being used. The various contexts **56** in which the voice-related feature may be used may include at home **62**, in the office **64**, at the gym **66**, on a busy street **68**, in a car **70**, at a sporting event **72**, at a restaurant **74**, and at a party **76**, among others. As should be appreciated, the typical ambient sounds **60** that occur on a busy street **68** may differ greatly from the typical ambient sounds **60** that occur at home **62** or in a car **70**.

[0058] The character of the ambient sounds **60** may vary from context **56** to context **56**. As described in greater detail below, the electronic device **10** may perform noise suppression **20** to filter the ambient sounds **60** based at least partly on user-specific noise suppression parameters. In some embodiments, these user-specific noise suppression parameters may be determined via voice training, in which a variety of different noise suppression parameters may be tested on an audio signal including a user voice sample and various distractors (simulated ambient sounds). The distractors employed in voice training may be chosen to mimic the ambient sounds **60** found in certain contexts **56**. Additionally, each of the contexts **56** may occur at certain locations and times, with varying amounts of electronic device **10** motion and ambient light, and/or with various volume levels of the voice signal **58** and the ambient sounds **60**. Thus, the electronic device **10** may filter the ambient sounds **60** using user-specific noise suppression parameters tailored to certain contexts **56**, as determined based on time, location, motion, ambient light, and/or volume level, for example.

[0059] FIG. **4** is a schematic block diagram of a technique **80** for performing the noise suppression **20** on the electronic device **10** when a voice-related feature of the electronic device **10** is in use. In the technique **80** of FIG. **4**, the voice-related feature involves two-way communication between a user and another person and may take place when a telephone or chat feature of the electronic device **10** is in use. However, it should be appreciated that the electronic device **10** also may perform the noise suppression **20** on an audio signal either received through the microphone **32** or the network interface **26** of the electronic device when two-way communication is not occurring.

[0060] In the noise suppression technique **80**, the microphone **32** of the electronic device **10** may obtain a user voice signal **58** and ambient sounds **60** present in the background. This first audio signal may be encoded by a codec **82** before entering noise suppression **20**. In the noise suppression **20**, transmit noise suppression (TX NS) **84** may be applied to the first audio signal. The manner in which noise suppression **20** occurs may be defined by certain noise suppression parameters (illustrated as transmit noise suppression (TX NS) parameters **86**) provided by the processor(s) **12**, memory **14**, or nonvolatile storage **16**, for example. As discussed in greater detail below, the TX NS parameters **86** may be user-specific noise suppression parameters determined by the processor(s) **12** and tailored to the user and/or context **56** of the electronic device **10**. After performing the noise suppression **20** at numeral **84**, the resulting signal may be passed to an uplink **88** through the network interface **26**.

[0061] A downlink **90** of the network interface **26** may receive a voice signal from another device (e.g., another telephone). Certain noise receiver noise suppression (RX NS) **92** may be applied to this incoming signal in the noise suppression **20**. The manner in which such noise suppression **20**

occurs may be defined by certain noise suppression parameters (illustrated as receive noise suppression (RX NS) parameters **94**) provided by the processor(s) **12**, memory **14**, or nonvolatile storage **16**, for example. Since the incoming audio signal previously may have been processed for noise suppression before leaving the sending device, the RX NS parameters **94** may be selected to be less strong than the TX NS parameters **86**. The resulting noise-suppressed signal may be decoded by the codec **82** and output to receiver circuitry and/or a speaker **48** of the electronic device **10**.

[0062] The TX NS parameters **86** and/or the RX NS parameters **94** may be specific to the user of the electronic device **10**. That is, as shown by a diagram **100** of FIG. **5**, the TX NS parameters **86** and the RX NS parameters **94** may be selected from user-specific noise suppression parameters **102** that are tailored to the user of the electronic device **10**. These user-specific noise suppression parameters **102** may be obtained in a variety of ways, such as through voice training **104**, based on a user voice profile **106**, and/or based on user-selectable settings **108**, as described in greater detail below.

[0063] Voice training **104** may allow the electronic device **10** to determine the user-specific noise suppression parameters **102** by way of testing a variety of noise suppression parameters combined with various distractors or simulated background noise. Certain embodiments for performing such voice training **104** are discussed in greater detail below with reference to FIGS. **7**-**14**. Additionally or alternatively, the electronic device **10** may determine the user-specific noise suppression parameters **102** based on a user voice profile **106** that may consider specific characteristics of the user's voice, as discussed in greater detail below with reference to FIGS. **15**-**17**. Additionally or alternatively, a user may indicate preferences for the user-specific noise suppression parameters **102** through certain user settings **108**, as discussed in greater detail below with reference to FIGS. **18** and **19**. Such user-selectable settings may include, for example, a noise suppression strength (e.g., low/medium/high) selector and/or a real-time user feedback selector to provide user feedback regarding the user's real-time voice quality.

[0064] In general, the electronic device **10** may employ the user-specific noise suppression parameters **102** when a voice-related feature of the electronic device is in use (e.g., the TX NS parameters **86** and the RX NS parameters **94** may be selected based on the user-specific noise suppression parameters **102**). In certain embodiments, the electronic device **10** may apply certain user-specific noise suppression parameters **102** during noise suppression **20** based on an identification of the user who is currently using the voice-related feature. Such a situation may occur, for example, when an electronic device **10** is used by other family members. Each member of the family may represent a user that may sometimes use a voice-related feature of the electronic device **10**. Under such multi-user conditions, the electronic device **10** may ascertain whether there are user-specific noise suppression parameters **102** associated with that user.

[0065] For example, FIG. **6** illustrates a flowchart **110** for applying certain user-specific noise suppression parameters **102** when a user has been identified. The flowchart **110** may begin when a user is using a voice-related feature of the electronic device **10** (block **112**). In carrying out the voice-related feature, the electronic device **10** may receive an audio signal that includes a user voice signal **58** and ambient sounds **60**. From the audio signal, the electronic device **10** generally may determine certain characteristics of the user's voice and/or may identify a user voice profile from the user voice signal **58** (block **114**). As discussed below, a user voice profile may represent information that identifies certain characteristics associated with the voice of a user.

[0066] If the voice profile detected at block **114** does not match any known users with whom user-specific noise suppression parameters **102** are associated (block **116**), the electronic device **10** may apply certain default noise suppression parameters for noise suppression **20** (block **118**). However, if the voice profile detected in block **114** does match a known user of the electronic device **10**, and the electronic device **10** currently stores user-specific noise suppression parameters **102** associated with that user, the electronic device **10** may instead apply the associated user-specific noise suppression parameters **102** (block **120**).

[0067] As mentioned above, the user-specific noise suppression parameters **102** may be determined based on a voice training sequence **104**. The initiation of such a voice training sequence **104** may be presented as an option to a user during an activation phase **130** of an embodiment of the electronic device **10**, such as the handheld device **34**, as shown in FIG. **7**. In general, such an activation phase **130** may take place when the handheld device **34** first joins a cellular network or first connects to a computer or other electronic device **132** via a communication cable **134**. During such an activation phase **130**, the handheld device **34** or the computer or other device **132** may provide a prompt **136** to initiate voice training. Upon selection of the prompt, a user may initiate the voice training **104**.

[0068] Additionally or alternatively, a voice training sequence **104** may begin when a user selects a setting of the electronic device **10** that causes the electronic device **10** to enter a voice training mode. As shown in FIG. **8**, a home screen **140** of the handheld device **34** may include a user-selectable button **142** that, when selected causes the handheld device **34** to display a settings screen **144**. When a user selects a user-selectable button **146** labeled "phone" on the settings screen **144**, the handheld device **34** may display a phone settings screen **148**. The phone settings screen **148** may include, among other things, a user-selectable button **150** labeled "voice training." When a user selects the voice training button **150**, a voice training **104** sequence may begin.

[0069] A flowchart **160** of FIG. **9** represents one embodiment of a method for performing the voice training **104**. The flowchart **160** may begin when the electronic device **10** prompts the user to speak while certain distractors (e.g., simulated ambient sounds) play in the background (block **162**). For example, the user may be asked to speak a certain word or phrase while certain distractors, such as rock music, babbling people, crumpled paper, and so forth, are playing aloud on the computer or other electronic device **132** or on a speaker **48** of the electronic device **10**. While such distractors are playing, the electronic device **10** may record a sample of the user's voice (block **164**). In some embodiments, blocks **162** and **164** may repeat while a variety of distractors are played to obtain several test audio signals that include both the user's voice and one or more distractors.

[0070] To determine which noise suppression parameters a user most prefers, the electronic device **10** may alternatingly apply certain test noise suppression parameters while noise suppression **20** is applied to the test audio signals before requesting feedback from the user. For example, the electronic device **10** may apply a first set of test noise suppression parameters, here labeled "A," to the test audio signal includ-

ing the user's voice sample and the one or more distractors, before outputting the audio to the user via a speaker **48** (block **166**). Next, the electronic device **10** may apply another set of test noise suppression parameters, here labeled "B," to the user's voice sample before outputting the audio to the user via the speaker **48** (block **168**). The user then may decide which of the two audio signals output by the electronic device **10** the user prefers (e.g., by selecting either "A" or "B" on a display **18** of the electronic device **10**) (block **170**).

[0071] The electronic device **10** may repeat the actions of blocks **166-170** with various test noise suppression parameters and with various distractors, learning more about the user's noise suppression preferences each time until a suitable set of user noise suppression preference data has been obtained (decision block **172**). Thus, the electronic device **10** may test the desirability of a variety of noise suppression parameters as actually applied to an audio signal containing the user's voice as well as certain common ambient sounds. In some embodiments, with each iteration of blocks **166-170**, the electronic device **10** may "tune" the test noise suppression parameters by gradually varying certain noise suppression parameters (e.g., gradually increasing or decreasing a noise suppression strength) until a user's noise suppression preferences have settled. In other embodiments, the electronic device **10** may test different types of noise suppression parameters in each iteration of blocks **166-170** (e.g., noise suppression strength in one iteration, noise suppression of certain frequencies in another iteration, and so forth). In any case, the blocks **166-170** may repeat until a desired number of user preferences have been obtained (decision block **172**).

[0072] Based on the indicated user preferences obtained at block(s) **170**, the electronic device **10** may develop user-specific noise suppression parameters **102** (block **174**). By way of example, the electronic device **10** may arrive at a preferred set of user-specific noise suppression parameters **102** when the iterations of blocks **166-170** have settled, based on the user feedback of block(s) **170**. In another example, if the iterations of blocks **166-170** each test a particular set of noise suppression parameters, the electronic device **10** may develop a comprehensive set of user-specific noise suppression parameters based on the indicated preferences to the particular parameters. The user-specific noise suppression parameters **102** may be stored in the memory **14** or the non-volatile storage **16** of the electronic device **10** (block **176**) for noise suppression when the same user later uses a voice-related feature of the electronic device **10**.

[0073] FIGS. **10-13** relate to specific manners in which the electronic device **10** may carry out the flowchart **160** of FIG. **9**. In particular, FIGS. **10** and **11** relate to blocks **162** and **164** of the flowchart **160** of FIG. **9**, and FIGS. **12** and **13**A-B relate to blocks **166-172**. Turning to FIG. **10**, a dual-device voice recording system **180** includes the computer or other electronic device **132** and the handheld device **34**. In some embodiments, the handheld device **34** may be joined to the computer or other electronic device **132** by way of a communication cable **134** or via wireless communication (e.g., an 802.11x Wi-Fi WLAN or a Bluetooth PAN). During the operation of the system **180**, the computer or other electronic device **132** may prompt the user to say a word or phrase while one or more of a variety of distractors **182** play in the background. Such distractors **182** may include, for example, sounds of crumpled paper **184**, babbling people **186**, white noise **188**, rock music **190**, and/or road noise **192**. The distractors **182** may additionally or alternatively include, for example, other noises commonly encountered in various contexts **56**, such as those discussed above with reference to FIG. **3**. These distractors **182**, playing aloud from the computer or other electronic device **132**, may be picked up by the microphone **32** of the handheld device **34** at the same time the user provides a user voice sample **194**. In this manner, the handheld device **34** may obtain test audio signals that include both a distractor **182** and a user voice sample **194**.

[0074] In another embodiment, represented by a single-device voice recording system **200** of FIG. **11**, the handheld device **34** may both output distractor(s) **182** and record a user voice sample **194** at the same time. As shown in FIG. **11**, the handheld device **34** may prompt a user to say a word or phrase for the user voice sample **194**. At the same time, a speaker **48** of the handheld device **34** may output one or more distractors **182**. The microphone **32** of the handheld device **34** then may record a test audio signal that includes both a currently playing distractor **182** and a user voice sample **194** without the computer or other electronic device **132**.

[0075] Corresponding to blocks **166-170**, FIG. **12** illustrates an embodiment for determining user's noise suppression preferences based on a choice of noise suppression parameters applied to a test audio signal. In particular, the electronic device **10**, here represented as the handheld device **34**, may apply a first set of noise suppression parameters ("A") to a test audio signal that includes both a user voice sample **194** and at least one distractor **182**. The handheld device **34** may output the noise-suppressed audio signal that results (numeral **212**). The handheld device **34** also may apply a second set of noise suppression parameters ("B") to the test audio signal before outputting the resulting noise-suppressed audio signal (numeral **214**).

[0076] When the user has heard the result of applying the two sets of noise suppression parameters "A" and "B" to the test audio signal, the handheld device **34** may ask the user, for example, "Did you prefer A or B?" (numeral **216**). The user then may indicate a noise suppression preference based on the output noise-suppressed signals. For example, the user may select either the first noise-suppressed audio signal ("A") or the second noise-suppressed audio signal ("B") via a screen **218** on the handheld device **34**. In some embodiments, the user may indicate a preference in other manners, such as by saying "A" or "B" aloud.

[0077] The electronic device **10** may determine the user preferences for specific noise suppression parameters in a variety of manners. A flowchart **220** of FIG. **13** represents one embodiment of a method for performing blocks **166-172** of the flowchart **160** of FIG. **9**. The flowchart **220** may begin when the electronic device **10** applies a set of noise suppression parameters that, for exemplary purposes, are labeled "A" and "B". If the user prefers the noise suppression parameters "A" (decision block **224**), the electronic device **10** may next apply new sets of noise suppression parameters that, for similarly descriptive purposes are labeled "C" and "D" (block **226**). In certain embodiments, the noise suppression parameters "C" and "D" may be variations of the noise suppression parameters "A." If a user prefers the noise suppression parameters "C" (decision block **228**), the electronic device may set the noise suppression parameters to be a combination of "A" and "C" (block **230**). If the user prefers the noise suppression parameters "D" (decision block **228**), the electronic device may set the user-specific noise suppression parameters to be a combination of the noise suppression parameters "A" and "D" (block **232**).

[0078] If, after block **222**, the user prefers the noise suppression parameters "B" (decision block **224**), the electronic device **10** may apply the new noise suppression parameters "C" and "D" (block **234**). In certain embodiments, the new noise suppression parameters "C" and "D" may be variations of the noise suppression parameters "B". If the user prefers the noise suppression parameters "C" (decision block **236**), the electronic device **10** may set the user-specific noise suppression parameters to be a combination of "B" and "C" (block **238**). Otherwise, if the user prefers the noise suppression parameters "D" (decision block **236**), the electronic device **10** may set the user-specific noise suppression parameters to be a combination of "B" and "D" (block **240**). As should be appreciated, the flowchart **220** is presented as only one manner of performing blocks **166-172** of the flowchart **160** of FIG. **9**. Accordingly, it should be understood that many more noise suppression parameters may be tested, and such parameters may be tested specifically in conjunction with certain distractors (e.g., in certain embodiments, the flowchart **220** may be repeated for test audio signals that respectively include each of the distractors **182**).

[0079] The voice training sequence **104** may be performed in other ways. For example, in one embodiment represented by a flowchart **250** of FIG. **14**, a user voice sample **194** first may be obtained without any distractors **182** playing in the background (block **252**). In general, such a user voice sample **194** may be obtained in a location with very little ambient sounds **60**, such as a quiet room, so that the user voice sample **194** has a relatively high signal-to-noise ratio (SNR). Thereafter, the electronic device **10** may mix the user voice sample **194** with the various distractors **182** electronically (block **254**). Thus, the electronic device **10** may produce one or more test audio signals having a variety of distractors **182** using a single user voice sample **194**.

[0080] Thereafter, the electronic device **10** may determine which noise suppression parameters a user most prefers to determine the user-specific noise suppression parameters **102**. In a manner similar to blocks **166-170** of FIG. **9**, the electronic device **10** may alternatingly apply certain test noise suppression parameters to the test audio signals obtained at block **254** to gauge user preferences (blocks **256-260**). The electronic device **10** may repeat the actions of blocks **256-260** with various test noise suppression parameters and with various distractors, learning more about the user's noise suppression preferences each time until a suitable set of user noise suppression preference data has been obtained (decision block **262**). Thus, the electronic device **10** may test the desirability of a variety of noise suppression parameters as applied to a test audio signal containing the user's voice as well as certain common ambient sounds.

[0081] Like block **174** of FIG. **9**, the electronic device **10** may develop user-specific noise suppression parameters **102** (block **264**). The user-specific noise suppression parameters **102** may be stored in the memory **14** or the nonvolatile storage **16** of the electronic device **10** (block **266**) for noise suppression when the same user later uses a voice-related feature of the electronic device **10**.

[0082] As mentioned above, certain embodiments of the present disclosure may involve obtaining a user voice sample **194** without distractors **182** playing aloud in the background. In some embodiments, the electronic device **10** may obtain such a user voice sample **194** the first time that the user uses a voice-related feature of the electronic device **10** in a quiet setting without disrupting the user. As represented in a flowchart **270** of FIG. **15**, in some embodiments, the electronic device **10** may obtain such a user voice sample **194** when the electronic device **10** first detects a sufficiently high signal-to-noise ratio (SNR) of audio containing the user's voice.

[0083] The flowchart **270** of FIG. **15** may begin when a user is using a voice-related feature of the electronic device **10** (block **272**). To ascertain an identity of the user, the electronic device **10** may detect a voice profile of the user based on an audio signal detected by the microphone **32** (block **274**). If the voice profile detected in block **274** represents the voice profile of the voice of a known user of the electronic device (decision block **276**), the electronic device **10** may apply the user-specific noise suppression parameters **102** associated with that user (block **278**). If the user's identity is unknown (decision block **276**), the electronic device **10** may initially apply default noise suppression parameters (block **280**).

[0084] The electronic device **10** may assess the current signal-to-noise ration (SNR) of the audio signal received by the microphone **32** while the voice-related feature is being used (block **282**). If the SNR is sufficiently high (e.g., above a preset threshold), the electronic device **10** may obtain a user voice sample **194** from the audio received by the microphone **32** (block **286**). If the SNR is not sufficiently high (e.g., below the threshold) (decision block **284**), the electronic device **10** may continue to apply the default noise suppression parameters (block **280**), continuing to at least periodically reassess the SNR. A user voice sample **194** obtained in this manner may be later employed in the voice training sequence **104** as discussed above with reference to FIG. **14**. In other embodiments, the electronic device **10** may employ such a user voice sample **194** to determine the user-specific noise suppression parameters **102** based on the user voice sample **194** itself.

[0085] Specifically, in addition to the voice training sequence **104**, the user-specified noise suppression parameters **102** may be determined based on certain characteristics associated with a user voice sample **194**. For example, FIG. **16** represents a flowchart **290** for determining the user-specific noise suppression parameters **102** based on such user voice characteristics. The flowchart **290** may begin when the electronic device **10** obtains a user voice sample **194** (block **292**). The user voice sample may be obtained, for example, according to the flowchart **270** of FIG. **15** or may be obtained when the electronic device **10** prompts the user to say a specific word or phrase. The electronic device next may analyze certain characteristics associated with the user voice sample (block **294**).

[0086] Based on the various characteristics associated with the user voice sample **194**, the electronic device **10** may determine the user-specific noise suppression parameters **102** (block **296**). For example, as shown by a voice characteristic diagram **300** of FIG. **17**, a user voice sample **194** may include a variety of voice sample characteristics **302**. Such characteristics **302** may include, among other things, an average frequency **304** of the user voice sample **194**, a variability of the frequency **306** of the user voice sample **194**, common speech sounds **308** associated with the user voice sample **194**, a frequency range **310** of the user voice sample **194**, formant locations **312** in the frequency of the user voice sample, and/or a dynamic range **314** of the user voice sample **194**. These characteristics may arise because different users may have different speech patterns. That is, the highness or deepness of a user's voice, a user's accent in speaking, and/or a

lisp, and so forth, may be taken into consideration to the extent they change a measurable character of speech, such as the characteristics **302**.

[0087] As mentioned above, the user-specific noise suppression parameters **102** also may be determined by a direct selection of user settings **108**. One such example appears in FIG. **18** as a user setting screen sequence **320** for a handheld device **32**. The screen sequence **320** may begin when the electronic device **10** displays a home screen **140** that includes a settings button **142**. Selecting the settings button **142** may cause the handheld device **34** to display a settings screen **144**. Selecting a user-selectable button **146** labeled "Phone" on the settings screen **144** may cause the handheld device **34** to display a phone settings screen **148**, which may include various user-selectable buttons, one of which may be a user-selectable button **322** labeled "Noise Suppression."

[0088] When a user selects the user-selectable button **322**, the handheld device **34** may display a noise suppression selection screen **324**. Through the noise suppression selection screen **324**, a user may select a noise suppression strength. For example, the user may select whether the noise suppression should be high, medium, or low strength via a selection wheel **326**. Selecting a higher noise suppression strength may result in the user-specific noise suppression parameters **102** suppressing more ambient sounds **60**, but possibly also suppressing more of the voice of the user **58**, in a received audio signal. Selecting a lower noise suppression strength may result in the user-specific noise suppression parameters **102** permitting more ambient sounds **60**, but also permitting more of the voice of the user **58**, to remain in a received audio signal.

[0089] In other embodiments, the user may adjust the user-specific noise suppression parameters **102** in real time while using a voice-related feature of the electronic device **10**. By way of example, as seen in a call-in-progress screen **330** of FIG. **19**, which may be displayed on the handheld device **34**, a user may provide a measure of voice phone call quality feedback **332**. In certain embodiments, the feedback may be represented by a number of selectable stars **334** to indicate the quality of the call. If the number of stars **334** selected by the user is high, it may be understood that the user is satisfied with the current user-specific noise suppression parameters **102**, and so the electronic device **10** may not change the noise suppression parameters. On the other hand, if the number of selected stars **334** is low, the electronic device **10** may vary the user-specific noise suppression parameters **102** until the number of stars **334** is increased, indicating user satisfaction. Additionally or alternatively, the call-in-progress screen **330** may include a real-time user-selectable noise suppression strength setting, such as that disclosed above with reference to FIG. **18**.

[0090] In certain embodiments, subsets of the user-specific noise suppression parameters **102** may be determined as associated with certain distractors **182** and/or certain contexts **60**. As illustrated by a parameter diagram **340** of FIG. **20**, the user-specific noise suppression parameters **102** may divided into subsets based on specific distractors **182**. For example, the user-specific noise suppression parameters **102** may include distractor-specific parameters **344-352**, which may represent noise suppression parameters chosen to filter certain ambient sounds **60** associated with a distractor **182** from an audio signal also including the voice of the user **58**. It should be understood that the user-specific noise suppression parameters **102** may include more or fewer distractor-specific parameters. For example, if different distractors **182** are tested during voice training **104**, the user-specific noise suppression parameters **102** may include different distractor-specific parameters.

[0091] The distractor-specific parameters **344-352** may be determined when the user-specific noise suppression parameters **102** are determined. For example, during voice training **104**, the electronic device **10** may test a number of noise suppression parameters using test audio signals including the various distractors **182**. Depending on a user's preferences relating to noise suppression for each distractor **182**, the electronic device may determine the distractor-specific parameters **344-352**. By way of example, the electronic device may determine the parameters for crumpled paper **344** based on a test audio signal that included the crumpled paper distractor **184**. As described below, the distractor-specific parameters of the parameter diagram **340** may later be recalled in specific instances, such as when the electronic device **10** is used in the presence of certain ambient sounds **60** and/or in certain contexts **56**.

[0092] Additionally or alternatively, subsets of the user-specific noise suppression parameters **102** may be defined relative to certain contexts **56** where a voice-related feature of the electronic device **10** may be used. For example, as represented by a parameter diagram **360** shown in FIG. **21**, the user-specific noise suppression parameters **102** may be divided into subsets based on which context **56** the noise suppression parameters may best be used. For example, the user-specific noise suppression parameters **102** may include context-specific parameters **364-378**, representing noise suppression parameters chosen to filter certain ambient sounds **60** that may be associated with specific contexts **56**. It should be understood that the user-specific noise suppression parameters **102** may include more or fewer context-specific parameters. For example, as discussed below, the electronic device **10** may be capable of identifying a variety of contexts **56**, each of which may have specific expected ambient sounds **60**. The user-specific noise suppression parameters **102** therefore may include different context-specific parameters to suppress noise in each of the identifiable contexts **56**.

[0093] Like the distractor-specific parameters **344-352**, the context-specific parameters **364-378** may be determined when the user-specific noise suppression parameters **102** are determined. To provide one example, during voice training **104**, the electronic device **10** may test a number of noise suppression parameters using test audio signals including the various distractors **182**. Depending on a user's preferences relating to noise suppression for each distractor **182**, the electronic device **10** may determine the context-specific parameters **364-378**.

[0094] The electronic device **10** may determine the context-specific parameters **364-378** based on the relationship between the contexts **56** of each of the context-specific parameters **364-378** and one or more distractors **182**. Specifically, it should be noted that each of the contexts **56** identifiable to the electronic device **10** may be associated with one or more specific distractors **182**. For example, the context **56** of being in a car **70** may be associated primarily with one distractor **182**, namely, road noise **192**. Thus, the context-specific parameters **376** for being in a car may be based on user preferences related to test audio signals that included road noise **192**. Similarly, the context **56** of a sporting event **72** may be associated with several distractors **182**, such as babbling people **186**, white noise **188**, and rock music **190**. Thus, the

context-specific parameters **368** for a sporting event may be based on a combination of user preferences related to test audio signals that included babbling people **186**, white noise **188**, and rock music **190**. This combination may be weighted to more heavily account for distractors **182** that are expected to more closely match the ambient sounds **60** of the context **56**.

[0095] As mentioned above, the user-specific noise suppression parameters **102** may be determined based on characteristics of the user voice sample **194** with or without the voice training **104** (e.g., as described above with reference to FIGS. **16** and **17**). Under such conditions, the electronic device **10** may additionally or alternatively determine the distractor-specific parameters **344-352** and/or the context-specific parameters **364-378** automatically (e.g., without user prompting). These noise suppression parameters **344-352** and/or **363-378** may be determined based on the expected performance of such noise suppression parameters when applied to the user voice sample **194** and certain distractors **182**.

[0096] When a voice-related feature of the electronic device **10** is in use, the electronic device **10** may tailor the noise suppression **20** both to the user and to the character of the ambient sounds **60** using the distractor-specific parameters **344-352** and/or the context-specific parameters **364-378**. Specifically, FIG. **22** illustrates an embodiment of a method for selecting and applying the distractor-specific parameters **344-352** based on the assessed character of ambient sounds **60**. FIG. **23** illustrates an embodiment of a method for selecting and applying the context-specific parameters **364-378** based on the identified context **56** where the electronic device **10** is used.

[0097] Turning to FIG. **22**, a flowchart **380** for selecting and applying the distractor-specific parameters **344-352** may begin when a voice-related feature of the electronic device **10** is in use (block **382**). Next, the electronic device **10** may determine the character of the ambient sounds **60** received by its microphone **32** (block **384**). In some embodiments, the electronic device **10** may differentiate between the ambient sounds **60** and the user's voice **58**, for example, based on volume level (e.g., the user's voice **58** generally may be louder than the ambient sounds **60**) and/or frequency (e.g., the ambient sounds **60** may occur outside of a frequency range associated with the user's voice **58**).

[0098] The character of the ambient sounds **60** may be similar to one or more of the distractors **182**. Thus, in some embodiments, the electronic device **10** may apply the one of the distractor-specific parameters **344-352** that most closely match the ambient sounds **60** (block **386**). For the context **56** of being at a restaurant **74**, for example, the ambient sounds **60** detected by the microphone **32** may most closely match babbling people **186**. The electronic device **10** thus may apply the distractor-specific parameter **346** when such ambient sounds **60** are detected. In other embodiments, the electronic device **10** may apply several of the distractor-specific parameters **344-352** that most closely match the ambient sounds **60**. These several distractor-specific parameters **344-352** may be weighted based on the similarity of the ambient sounds **60** to the corresponding distractors **182**. For example, the context **56** of a sporting event **72** may have ambient sounds **60** similar to several distractors **182**, such as babbling people **186**, white noise **188**, and rock music **190**. When such ambient sounds **60** are detected, the electronic device **10** may apply the several associated distractor-specific parameters **346**, **348**, and/or **350** in proportion to the similarity of each to the ambient sounds **60**.

[0099] In a similar manner, the electronic device **10** may select and apply the context-specific parameters **364-378** based on an identified context **56** where the electronic device **10** is used. Turning to FIG. **23**, a flowchart **390** for doing so may begin when a voice-related feature of the electronic device **10** is in use (block **392**). Next, the electronic device **10** may determine the current context **56** in which the electronic device **10** is being used (block **394**). Specifically, the electronic device **10** may consider a variety of device context factors (discussed in greater detail below with reference to FIG. **24**). Based on the context **56** in which the electronic device **10** is determined to be in use, the electronic device **10** may apply the associated one of the context-specific parameters **364-378** (block **396**).

[0100] As shown by a device context factor diagram **400** of FIG. **24**, the electronic device **10** may consider a variety of device context factors **402** to identify the current context **56** in which the electronic device **10** is being used. These device context factors **402** may be considered alone or in combination in various embodiments and, in some cases, the device context factors **402** may be weighted. That is, device context factors **402** more likely to correctly predict the current context **56** may be given more weight in determining the context **56**, while device context factors **402** less likely to correctly predict the current context **56** may be given less weight.

[0101] For example, a first factor **404** of the device context factors **402** may be the character of the ambient sounds **60** detected by the microphone **32** of the electronic device **10**. Since the character of the ambient sounds **60** may relate to the context **56**, the electronic device **10** may determine the context **56** based at least partly on such an analysis.

[0102] A second factor **406** of the device context factors **402** may be the current date or time of day. In some embodiments, the electronic device **10** may compare the current date and/or time with a calendar feature of the electronic device **10** to determine the context. By way of example, if the calendar feature indicates that the user is expected to be at dinner, the second factor **406** may weigh in favor of determining the context **56** to be a restaurant **74**. In another example, since a user may be likely to commute in the morning or late afternoon, at such times the second factor **406** may weigh in favor of determining the context **56** to be a car **70**.

[0103] A third factor **408** of the device context factors **402** may be the current location of the electronic device **10**, which may be determined by the location-sensing circuitry **22**. Using the third factor **408**, the electronic device **10** may consider its current location in determining the context **56** by, for example, comparing the current location to a known location in a map feature of the electronic device **10** (e.g., a restaurant **74** or office **64**) or to locations where the electronic device **10** is frequently located (which may indicate, for example, an office **64** or home **62**).

[0104] A fourth factor **410** of the device context factors **402** may be the amount of ambient light detected around the electronic device **10** via, for example, the image capture circuitry **28** of the electronic device. By way of example, a high amount of ambient light may be associated with certain contexts **56** located outdoors (e.g., a busy street **68**). Under such conditions, the factor **410** may weigh in favor of a context **56** located outdoors. A lower amount of ambient light, by contrast, may be associated with certain contexts **56** located

indoors (e.g., home **62**), in which case the factor **410** may weigh in favor of such an indoor context **56**.

[0105] A fifth factor **412** of the device context factors **402** may be detected motion of the electronic device **10**. Such motion may be detected based on the accelerometers and/or magnetometer **30** and/or based on changes in location over time as determined by the location-sensing circuitry **22**. Motion may suggest a given context **56** in a variety of ways. For example, when the electronic device **10** is detected to be moving very quickly (e.g., faster than 20 miles per hour), the factor **412** may weigh in favor of the electronic device **10** being in a car **70** or similar form of transportation. When the electronic device **10** is moving randomly, the factor **412** may weigh in favor of contexts in which a user of the electronic device **10** may be moving about (e.g., at a gym **66** or a party **76**). When the electronic device **10** is mostly stationary, the factor **412** may weigh in favor of contexts **56** in which the user is seated at one location for a period of time (e.g., an office **64** or restaurant **74**).

[0106] A sixth factor **414** of the device context factors **402** may be a connection to another device (e.g., a Bluetooth handset). For example, a Bluetooth connection to an automotive hands-free phone system may cause the sixth factor **414** to weigh in favor of determining the context **56** to be in a car **70**.

[0107] In some embodiments, the electronic device **10** may determine the user-specific noise suppression parameters **102** based on a user voice profile associated with a given user of the electronic device **10**. The resulting user-specific noise suppression parameters **102** may cause the noise suppression **20** to isolate ambient sounds **60** that do not appear associated with the user voice profile, and thus may be understood to likely be noise. FIGS. **25-29** relate to such techniques.

[0108] As shown in FIG. **25**, a flowchart **420** for obtaining a user voice profile may begin when the electronic device **10** obtains a voice sample (block **422**). Such a voice sample may be obtained in any of the manners described above. The electronic device **10** may analyze certain of the characteristics of the voice sample, such as those discussed above with reference to FIG. (block **424**). The specific characteristics may be quantified and stored as a voice profile of the user (block **426**). The determined user voice profile may be employed to tailor the noise suppression **20** to the user's voice, as discussed below. In addition, the user voice profile may enable the electronic device **10** to identify when a particular user is using a voice-related feature of the electronic device **10**, such as discussed above with reference to FIG. **15**.

[0109] With such a voice profile, the electronic device **10** may perform the noise suppression **20** in a manner best applicable to that user's voice. In one embodiment, as represented by a flowchart **430** of FIG. **26**, the electronic device **10** may suppress frequencies of an audio signal that more likely correspond to ambient sounds **60** than a voice of a user **58**, while enhancing frequencies more likely to correspond to the voice signal **58**. The flowchart **430** may begin when a user is using a voice-related feature of the electronic device **10** (block **432**). The electronic device **10** may compare an audio signal received that includes both a user voice signal **58** and ambient sounds **60** to a user voice profile associated with the user currently speaking into the electronic device **10** (block **434**). To tailor the noise suppression **20** to the user's voice, the electronic device may perform noise suppression **20** in a manner that suppresses frequencies of the audio signal that are not associated with the user voice profile and by amplifying frequencies of the audio signal that are associated with the user voice profile (block **436**).

[0110] One manner of doing so is shown through FIGS. **27-29**, which represent plots modeling an audio signal, a user voice profile, and an outgoing noise-suppressed signal. Turning to FIG. **27**, a plot **440** represents an audio signal that has been received into the microphone **32** of the electronic device **10** while a voice-related feature is in use and transformed into the frequency domain. An ordinate **442** represents a magnitude of the frequencies of the audio signal and an abscissa **444** represents various discrete frequency components of the audio signal. It should be understood that any suitable transform, such as a fast Fourier transform (FFT), may be employed to transform the audio signal into the frequency domain. Similarly, the audio signal may be divided into any suitable number of discrete frequency components (e.g., **40**, **128**, **256**, etc.).

[0111] By contrast, a plot **450** of FIG. **28** is a plot modeling frequencies associated with a user voice profile. An ordinate **452** represents a magnitude of the frequencies of the user voice profile and an abscissa **454** represents discrete frequency components of the user voice profile. Comparing the audio signal plot **440** of FIG. **27** to the user voice profile plot **450** of FIG. **28**, it may be seen that the modeled audio signal includes range of frequencies not typically associated with the user voice profile. That is, the modeled audio signal may be likely to include other ambient sounds **60** in addition to the user's voice.

[0112] From such a comparison, when the electronic device **10** carries out noise suppression **20**, it may determine or select the user-specific noise suppression parameters **102** such that the frequencies of the audio signal of the plot **440** that correspond to the frequencies of the user voice profile of the plot **450** are generally amplified, while the other frequencies are generally suppressed. Such a resulting noise-suppressed audio signal is modeled by a plot **460** of FIG. **29**. An ordinate **462** of the plot **460** represents a magnitude of the frequencies of the noise-suppressed audio signal and an abscissa **464** represents discrete frequency components of the noise-suppressed signal. An amplified portion **466** of the plot **460** generally corresponds to the frequencies found in the user voice profile. By contrast, a suppressed portion **468** of the plot **460** corresponds to frequencies of the noise-suppressed signal that are not associated with the user profile of plot **450**. In some embodiments, a greater amount of noise suppression may be applied to frequencies not associated with the user voice profile of plot **450**, while a lesser amount of noise suppression may be applied to the portion **466**, which may or may not be amplified.

[0113] The above discussion generally focused on determining the user-specific noise suppression parameters **102** for performing the TX NS **84** of the noise suppression **20** on an outgoing audio signal, as shown in FIG. **4**. However, as mentioned above, the user-specific noise suppression parameters **102** also may be used for performing the RX NS **92** on an incoming audio signal from another device. Since such an incoming audio signal from another device will not include the user's own voice, in certain embodiments, the user-specific noise suppression parameters **102** may be determined based on voice training **104** that involves several test voices in addition to several distractors **182**.

[0114] For example, as presented by a flowchart **470** of FIG. **30**, the electronic device **10** may determine the user-specific noise suppression parameters **102** via voice training

104 involving pre-recorded or simulated voices and simulated distractors 182. Such an embodiment of the voice training 104 may involve test audio signals that include a variety of difference voices and distractors 182. The flowchart 470 may begin when a user initiates voice training 104 (block 472). Rather than perform the voice training 104 based solely on the user's own voice, the electronic device 10 may apply various noise suppression parameters to various test audio signals containing various voices, one of which may be the user's voice in certain embodiments (block 474). Thereafter, the electronic device 10 may ascertain the user's preferences for different noise suppression parameters tested on the various test audio signals. As should be appreciated, block 474 may be carried out in a manner similar to blocks 166-170 of FIG. 9.

[0115] Based on the feedback from the user at block 474, the electronic device 10 may develop user-specific noise suppression parameters 102 (block 476). The user-specific parameters 102 developed based on the flowchart 470 of FIG. 30 may be well suited for application to a received audio signal (e.g., used to form the RX NS parameters 94, as shown in FIG. 4). In particular, a received audio signal will includes different voices when the electronic device 10 is used as a telephone by a "near-end" user to speak with "far-end" users. Thus, as shown by a flowchart 480 of FIG. 31, the user-specific noise suppression parameters 102, determined using a technique such as that discussed with reference to FIG. 30, may be applied to the received audio signal from a far-end user depending on the character of the far-end user's voice in the received audio signal.

[0116] The flowchart 480 may begin when a voice-related feature of the electronic device 10, such as a telephone or chat feature, is in use and is receiving an audio signal from another electronic device 10 that includes a far-end user's voice (block 482). Subsequently, the electronic device 10 may determine the character of the far-end user's voice in the audio signal (block 484). Doing so may entail, for example, comparing the far-end user's voice in the received audio signal with certain other voices that were tested during the voice training 104 (when carried out as discussed above with reference to FIG. 30). The electronic device 10 next may apply the user-specific noise suppression parameters 102 that correspond to one of the other voices that is most similar to the end-user's voice (block 486).

[0117] In general, when a first electronic device 10 receives an audio signal containing a far-end user's voice from a second electronic device 10 during two-way communication, such an audio signal already may have been processed for noise suppression in the second electronic device 10. According to certain embodiments, such noise suppression in the second electronic device 10 may be tailored to the near-end user of the first electronic 10, as described by a flowchart 490 of FIG. 32. The flowchart 490 may begin when the first electronic device 10 (e.g., handheld device 34A of FIG. 33) is or is about to begin receiving an audio signal of the far-end user's voice from the second electronic device 10 (e.g., handheld device 34B) (block 492). The first electronic device 10 may transmit the user-specific noise suppression parameters 102, previously determined by the near-end user, to the second electronic device 10 (block 494). Thereafter, the second electronic device 10 may apply those user-specific noise suppression parameters 102 toward the noise suppression of the far-end user's voice in the outgoing audio signal (block 496). Thus, the audio signal including the far-end user's voice that is transmitted from the second electronic device 10 to the first electronic device 10 may have the noise-suppression characteristics preferred by the near-end user of the first electronic device 10.

[0118] The above-discussed technique of FIG. 32 may be employed systematically using two electronic devices 10, illustrated as a system 500 of FIG. 33 including handheld devices 34A and 34B with similar noise suppression capabilities. When the handheld devices 34A and 34B are used for intercommunication by a near-end user and a far-end user respectively over a network (e.g., using a telephone or chat feature), the handheld devices 34A and 34B may exchange the user-specific noise suppression parameters 102 associated with their respective users (blocks 504 and 506). That is, the handheld device 34B may receive the user-specific noise suppression parameters 102 associated with the near-end user of the handheld device 34A. Likewise, the handheld device 34A may receive the user-specific noise suppression parameters 102 associated with the far-end user of the handheld device 34B. Thereafter, the handheld device 34A may perform noise suppression 20 on the near-end user's audio signal based on the far-end user's user-specific noise suppression parameters 102. Likewise, the handheld device 34B may perform noise suppression 20 on the far-end user's audio signal based on the near-end user's user-specific noise suppression parameters 102. In this way, the respective users of the handheld devices 34A and 34B may hear audio signals from the other whose noise suppression matches their respective preferences.

[0119] The specific embodiments described above have been shown by way of example, and it should be understood that these embodiments may be susceptible to various modifications and alternative forms. It should be further understood that the claims are not intended to be limited to the particular forms disclosed, but rather to cover all modifications, equivalents, and alternatives falling within the spirit and scope of this disclosure.

What is claimed is:

1. A method comprising:

receiving an audio signal that includes a user voice in an electronic device when a voice-related feature of the electronic device is in use; and

suppressing noise in the audio signal while substantially preserving the user voice based at least in part on user-specific noise suppression parameters using the electronic device, wherein the user-specific noise suppression parameters are based at least in part on a user noise suppression preference or a user voice profile, or a combination thereof.

2. The method of claim 1, wherein the user noise suppression preference is based at least in part on a user noise suppression training sequence.

3. The method of claim 2, wherein the user noise suppression training sequence comprises receiving in the electronic device a user selection of preferred noise parameters after noise suppression parameters have been tested on a test audio signal and played back to the user.

4. The method of claim 2, wherein the user noise suppression training sequence comprises testing noise suppression parameters as applied to a test audio signal that includes a user voice sample and at least one distractor.

5. The method of claim 1, wherein the user noise suppression preference is based at least in part on a user-selected noise suppression setting.

6. The method of claim **5**, wherein the user-selected noise suppression setting comprises a noise suppression strength setting.

7. The method of claim **5**, wherein the user-selected noise suppression setting is user-selectable in real time while the voice-related feature of the electronic device is in use.

8. The method of claim **1**, wherein the user-specific noise suppression parameters suppress noise in the audio signal while substantially preserving the user voice at least in part by amplifying frequencies associated with the user voice profile.

9. The method of claim **1**, wherein the user-specific noise suppression parameters suppress noise in the audio signal while substantially preserving the user voice at least in part by suppressing frequencies not associated with the user voice profile.

10. An article of manufacture comprising:

one or more tangible, machine-readable storage media having instructions encoded thereon for execution by a processor, the instructions comprising:

instructions to determine a test audio signal that includes a user voice sample and at least one distractor;

instructions to apply noise suppression to the test audio signal based at least in part on first noise suppression parameters to obtain a first noise-suppressed audio signal;

instructions to cause the first noise-suppressed audio signal to be output to a speaker;

instructions to apply noise suppression to the test audio signal based at least in part on second noise suppression parameters to obtain a second noise-suppressed audio signal;

instructions to cause the second noise-suppressed audio signal to be output to the speaker;

instructions to obtain an indication of a user preference of the first noise-suppressed audio signal or the second noise suppressed audio signal; and

instructions to determine user-specific noise suppression parameters based at least in part on the first noise suppression parameters or the second noise suppression parameters, or a combination thereof, depending on the indication of the user preference of the first noise-suppressed signal or the second noise-suppressed signal, wherein the user-specific noise suppression parameters are configured to suppress noise when a voice-related feature of the electronic device is in use.

11. The article of manufacture of claim **10**, wherein the instructions to determine the test audio signal comprise instructions to record the user voice sample using a microphone while the distractor is playing aloud on the speaker.

12. The article of manufacture of claim **10**, wherein the instructions to determine the test audio signal comprise instructions to record the user voice sample using a microphone while the distractor is playing aloud on another device.

13. The article of manufacture of claim **10**, wherein the instructions to determine the test audio signal comprise instructions to record the user voice sample using a microphone and to electronically mix the user voice sample with the distractor.

14. The article of manufacture of claim **10**, comprising:

instructions to apply noise suppression to the test audio signal based at least in part on third noise suppression parameters to obtain a third noise-suppressed audio signal;

instructions to cause the third noise-suppressed audio signal to be output to the speaker;

instructions to apply noise suppression to the test audio signal based at least in part on fourth noise suppression parameters to obtain a fourth noise-suppressed audio signal;

instructions to cause the fourth noise-suppressed audio signal to be output to the speaker;

instructions to obtain an indication of a user preference of the third noise-suppressed audio signal or the fourth noise-suppressed audio signal; and

instructions to determine the user-specific noise suppression parameters based at least in part on the first noise suppression parameters, the second noise suppression parameters, the third noise suppression parameters, or the fourth noise suppression parameters, or a combination thereof, depending on the indication of the user preference of the third noise-suppressed audio signal or the fourth noise-suppressed audio signal.

15. The article of manufacture of claim **14**, comprising instructions to determine the third noise suppression parameters and the fourth noise suppression parameters based at least in part on the user preference of the first noise-suppressed audio signal or the second noise-suppressed audio signal.

16. An electronic device comprising:

a microphone configured to obtain an audio signal that includes a user voice and ambient sounds;

noise suppression circuitry configured to apply noise suppression to the audio signal based at least in part on user- and context-specific noise suppression parameters to suppress the ambient sounds of the audio signal;

memory configured to store a plurality of noise suppression parameters determined based at least in part on tests of noise suppression parameters applied to a user voice sample and a plurality of distractors; and

data processing circuitry configured to provide the user- and context-specific noise suppression parameters to the noise suppression circuitry by determining a current context of use of the electronic device and selecting at least one of the plurality of noise suppression parameters, wherein the at least one of the plurality of noise suppression parameters was determined based at least in part on a test of noise suppression parameters applied to the user voice sample and at least one of the plurality of distractors, wherein the at least one of the plurality of distractors is associated with the current context of use.

17. The electronic device of claim **16**, wherein the data processing circuitry is configured to determine the current context of use of the electronic device by analyzing the ambient sounds of the audio signal and to determine the at least one of the plurality of distractors associated with the current context of use by determining which of the plurality of distractors are similar to the ambient sounds.

18. The electronic device of claim **16**, wherein the data processing circuitry is configured to determine the current context of use of the electronic device based at least in part on a date or time, or a combination thereof, from an internal clock of the electronic device; a location from location-sensing circuitry of the electronic device; an amount of ambient light from image-capture circuitry of the electronic device; a motion of the electronic device from motion-sensing circuitry of the electronic device; a connection to another electronic device; or a volume of the ambient sounds from the micro-

phone; or any combination thereof; and wherein the data processing circuitry is configured to determine the at least one of the plurality of distractors associated with the current context of use by determining which of the plurality of distractors are similar to expected ambient sounds in the determined context of use.

19. An electronic device comprising:

a microphone configured to obtain an audio signal that includes a user voice and ambient sounds;

noise suppression circuitry configured to apply noise suppression to the audio signal based at least in part on user-specific noise suppression parameters to suppress the ambient sounds of the audio signal; and

data processing circuitry configured to provide the user-specific noise suppression parameters, wherein the data processing circuitry is configured to determine the user-specific noise suppression parameters based at least in part on a user voice profile associated with the user voice.

20. The electronic device of claim **19**, wherein the data processing circuitry is configured to determine the user voice profile based at least in part on a user voice sample, wherein the microphone is configured to obtain the user voice sample during an activation period of the electronic device.

21. The electronic device of claim **19**, wherein the data processing circuitry is configured to determine the user voice profile based at least in part on a user voice sample, wherein the microphone is configured to obtain the user voice sample by monitoring a signal-to-noise ratio of another audio signal obtained while a voice-related feature of the electronic device is in use and recording the other audio signal when the signal-to-noise ratio of the other audio signal exceeds a threshold.

22. The electronic device of claim **19**, wherein the data processing circuitry is configured to determine whether the user voice corresponds to a known user and, when the user voice corresponds to the known user, recalling the user voice profile associated with the user voice.

23. The electronic device of claim **19**, wherein the data processing circuitry is configured to determine whether the user voice corresponds to a known user and, when the user voice does not correspond to the known user, determining the user voice profile associated with the user voice by obtaining a user voice sample and determining the user voice profile based at least in part on the user voice sample.

24. A system comprising:

a first electronic device configured to obtain a first user voice signal from a microphone associated with the first electronic device, to provide the first user voice signal to a second electronic device, and to receive second user noise suppression parameters from the second electronic device, wherein the first electronic device is configured to apply noise suppression to the first user voice signal based at least in part on the second user noise suppression parameters before providing the first user voice signal to the second electronic device.

25. The system of claim **24**, wherein the first electronic device is configured to provide first user noise suppression parameters to the second electronic device and to receive a second user voice signal from the second electronic device, wherein the second user voice signal has had noise suppression applied thereto based at least in part on the first user noise suppression parameters before being received by the first electronic device.

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